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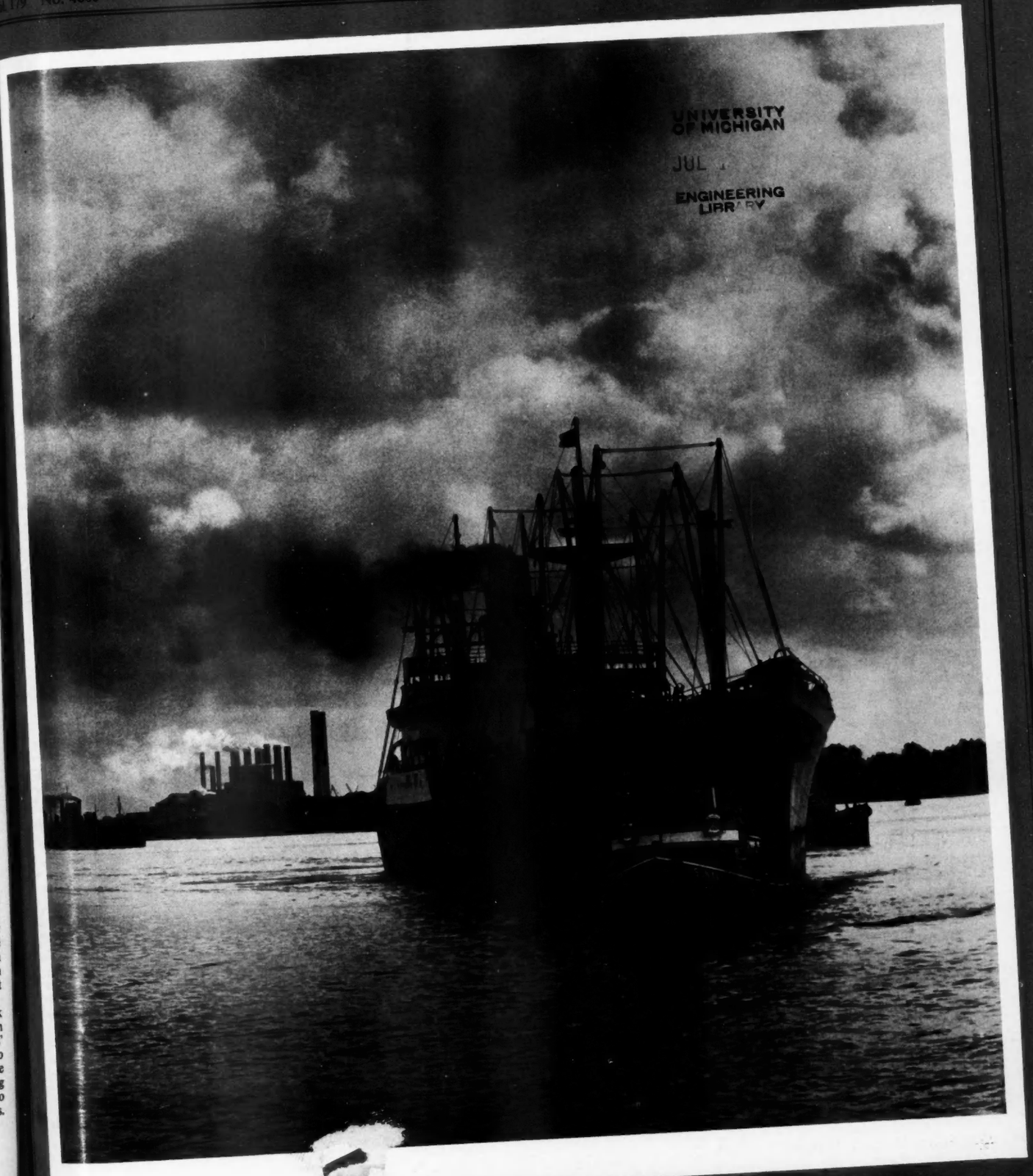

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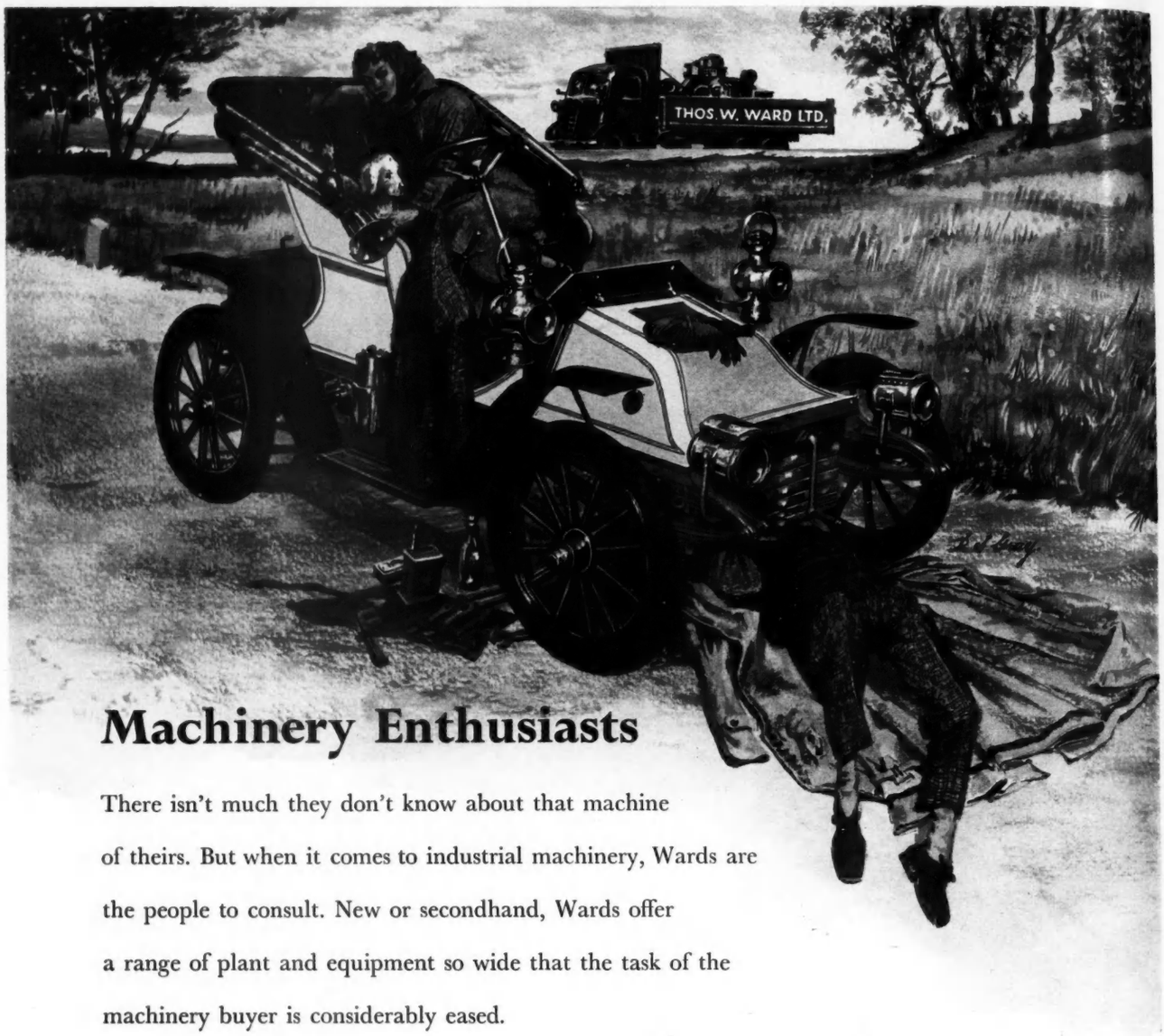

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IMPERIAL COLLEGE

A SERIOUS shortage of scientists and engineers appears to be overtaking Britain. In the decade since the war the danger has been foreseen and measures have been taken to forestall it. But now the shortage appears to be with us. Though there is no official estimate of the numbers, there are sufficient indications to justify us in sounding an alarm. Plans for expanding the Imperial College of Science and Technology were announced more than two years ago, yet to-day there is opposition to these plans from people who are in no way concerned with the education of engineers and scientists.

A letter signed by the president, chairman and honorary secretary of the Kensington Society, and published in *The Times* of May 23, complains that "One hears, with some concern, of a large scheme which appears to involve the redevelopment of the important site comprising the Imperial Institute, the Imperial College of Science, the Royal School of Needlework, the City and Guilds Institute, with other properties . . . The most serious implication appears to be the destruction of the Imperial Institute building with its towers and domes. We feel this should not be done without public discussion and without serious consideration of the possibility of incorporating this historic building in the development plans of the Imperial College." It is right to permit public discussion of such an important proposal, but it is wrong for the discussion to be delayed nearly two years when the country can ill afford the slightest delay in the development of technical education facilities. It is also incorrect to speak of the City and Guilds "Institute" in this connection, or to refer at all to the Royal School of Needlework, which is not involved in the plans for expansion.

The limiting factor in the rate at which nuclear power stations can be built is the limited number of skilled personnel, according to a statement the Minister of Fuel and Power, Mr. Geoffrey Lloyd, made in the House of Commons last week. He was asked why the programme for nuclear power stations could not be implemented more quickly, and he replied that although engineers had completed training courses arranged by the Atomic Energy Authority, there was this shortage of skilled personnel. Training will clearly take time, however many engineers are available, but the situation to which the Minister referred reflects the overall national shortage which is apparently being created. Several of the major industries—railways, roads, coal mines—and many smaller industries such as electronic instruments, will be increasing their demands for staff. The "situations vacant" columns of this journal and others is a rough-and-ready guide to the present excess of demand over supply, though it is also an index of the rate of change of jobs to conform with the rapidly changing pattern of industrial production.

Imperial College is specially important because it is the largest training centre in science and technology. Its expansion is the alternative, officially approved, to the creation of a new technological institute on the American model. Approval has been given to the expansion by the Government, the University Grants Committee, London University, the Governing Body of Imperial College, and the three colleges which constitute Imperial College. The Governing Body passed the academic plan in November, 1953, and at the same time gave their general approval to the preliminary results of their architect's consideration of what could be done on the South Kensington site. Last year they obtained licences to proceed with an extension to the City and Guilds College and the Royal School of Mines, an extension to the Chemical Engineering building, the addition of two storeys to the Union building, and a new building for aeronautics. The academic staff is being increased—professors, readers and lecturers in new branches of science and technology, as well as additional staff for the increased number of students in existing courses. The engineering faculty is being enlarged much more than the science faculty, and there is to be a post-graduate increase of 160 per cent. compared with an undergraduate increase of about 44 per cent. The intention is to provide eventually for about 1,500 undergraduates and 1,500 post-graduates.

It is 48 years since the Royal College of Science, the Royal School of Mines and the Central Technical College were federated and granted a Royal Charter as the Imperial College. The College's future contribution to the national asset of educated men and women will be even greater than it has been in the past. Every graduate will be needed, and with the growing need for further specialised education every post-graduate will be needed. Engineering firms have a direct interest in the development of Imperial College, not only for filling vacancies on their staffs, but by virtue of their liberal donations towards the cost of the teaching and research staff, scholarships, bursaries and maintenance grants. It is unfortunate that this vital expansion should threaten the Imperial Institute, which does admirable work for the Commonwealth by means of permanent exhibitions and educational activities. But there is no time to lose in resolving the difficulties. An official statement at the earliest possible moment would be welcomed

Weekly Survey

Cover Picture. *A morning arrival for the Royal Docks, London, sails up the Thames, leaving Barking power station in the background. London is by far the greatest seaport in Great Britain, both in tonnage of vessels handled and value of imports and exports. The Royal Docks are the Victoria and Albert and the King George V docks, covering* 1,102 *acres, of which* 235 *acres are water. They have special facilities for handling frozen and chilled meat, grain, tobacco, and bananas. The King George V dock, opened in* 1921, *provides accommodation for vessels up to* 30,000 *tons.*

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ANNUAL GUARANTEED WAGE

The agreement recently concluded between the Ford Motor Company in the United States and their 140,000 employees, under threat of strike action, is the first major step along the road to greater employee security, a road mapped out as early as 1947, in a report to President Truman (the Latimer report). The United Automobile Workers' Union had demanded a guarantee that 80 per cent. of their members' wages would be paid when they were laid off, which occurs most frequently when works close for retooling for new models or at the seasonal troughs in demand. The severe fluctuations in employment in the motor vehicle and durable consumer-goods industries have long been recognised as harmful by both parties and Ford's lead is expected to be widely followed. The agreement provides a fund of 55 million dols. to be set up by the company for benefits which, when added to unemployment payments by the State, will guarantee the laid-off worker 60 to 65 per cent. of his normal pay packet for a maximum of 26 weeks. To fill the gap between this and the union's demands the agreement includes a number of other benefits. The automatic annual increase of pay to compensate for the increased efficiency of machinery—the "annual improvement factor"—is to be raised from 5 cents. to 6 cents. an hour; some trades will have increased pay, and there will be a liberalised pension fund, improved hospital and medical benefits, one additional paid holiday each year and triple pay for holiday work.

The trend is unmistakably towards more welfare as well as greater security. The Latimer report argued that the annual guaranteed wage when it became general would tend to stabilise purchasing power and thus lessen short-period fluctuations of trade, and that by lessening the fears of unemployment it would take away the main support for restrictive practices. One of its most certain effects is to reduce labour turnover, since the employee will have to work through a qualifying period to secure the guarantee. Coupled with the welfare features of the agreement, it will tend to make the employees more closely identified with the fortunes of the company, though Ford's offer to sell them part of the equity on favourable terms—similar to I.C.I.'s scheme—was refused.

It may be doubted whether any but the wealthiest country in the world can afford "A.G.W." In Britain, unemployment is much too low to make it worth the unions' while to press for it. In the last analysis, however, "A.G.W." is no substitute for full employment; it is a heavy fixed charge that could not be borne even by large companies during a prolonged slump. Also it would tend to quicken the fall of any company losing ground in its industry.

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ONE MORE FORM

Nature abhors a vacuum. At times there seem to be forces at work in the running of a country's economy which establish a similar law on form-filling. Such would appear to be the case with the recent announcement that the Government wish to make a sample investigation into the capital-investment plans of industry. The element of law arises thus: when physical controls were in operation, the Government had a mass of statistical data from which they could extract, incidentally, a good deal of information about the investment intentions of companies; create a vacuum by dispensing with controls, then there must perforce be a sample investigation to obtain what was before incidental but vital information.

The immediate reaction to yet another form on top of the censuses of distribution and production (there are, of course, others) is that here is nothing which may even in metaphor be dignified with the name of "law," but only a singularly apt example of the Gallic proverb *plus ça change, plus c'est la même chose*. Such a cynical view is understandable but not really justified. If industry is to operate with the maximum freedom consonant with a general guidance of the economy by the Government, it is necessary for that guidance to be efficient. To be efficient, those exercising it must be well-informed. They must know not only what is going on, but what is likely to happen in the future. The more intelligent, informed a view they can take, the more confident are they likely to become that they can confine their activities to the broad direction of policy and the less danger that they will want to improvise with crude controls in a panic at short notice. Such a Government machine operates best when it is least obtrusive.

There is no doubt that a knowledge of industry's investment plans will help those at the centre to foresee the trend of economic events more clearly (especially when the country faces a huge investment programme with limited resources, as at present). There is, in fact, a much better case for this kind of investigation than for the elaborate censuses—judging it in relation to the immediate and patent gain to industry. But the questionnaire must be as brief and simple as possible if it is not to give more exasperation than information.

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FRIEDRICH KRUPP OF ESSEN

Since the strength of German competition is one of the major factors in British economic life to-day, any assessment of their future by leading German manufacturers is worthy of notice—none more so than one by Krupps. The total number employed in the parent and associated companies is 39,400 and the range of manufactures includes locomotives, Diesel engines, commercial vehicles, cranes, machine-tools, electrical power plant, iron and steel plant, printing machinery and ships. One of the main features in a recent speech by Herr Alfried Krupp is the emphasis on "fierce competition in all markets" which requires "new types of goods, improved quality and keen prices." Most British manufacturers (and particularly the shipbuilders) will be ready to testify that German prices are already keen enough.

German shipyards have been booking a high proportion of world orders for new tonnage on price and delivery and are now very fully occupied. Krupp's subsidiary, A. G. Weser of Bremen, now employ 8,800 men in their rebuilt yard at Bremen. For all their competitiveness, sales of some Krupps products have been falling. Output of locomotives in 1954 did not reach the 1953 level, and prices fell with the reduced flow of orders. Realising the continuing need for strengthening their organisation, Krupps are pursuing a policy of taking up new products and dropping old ones. Of course, their long experience in steel (dating from 1811 when Friedrich Krupp first tried to manufacture "English crucible steel") is standing them in good stead. Their services are at present much in demand in a number of foreign countries anxious to develop their own industries. The Rourkela million-ton steelworks in India (jointly with Demag), as well as steel mills in Pakistan, Spain and Greece, are among the projects which Krupps-Technik have on hand. But Krupps are branching into some entirely new fields.

For example, they propose to start large-scale production of machinery based on American patents for rayon and allied products. An agreement with the Von Kohorn International Corporation of New York, who have already built 50 synthetic plants, was signed a few weeks ago. Inevitably Krupps are finding that it needs a great deal of capital to keep abreast of the times. The financing of their reconstruction and reorganisation schemes has led them to incur long-term liabilities of £4·25 million, "which represent a heavy burden by way of interest and amortisation." All in all, Krupps are finding the facts of economic life no less (and no more) complicated than their British competitors.

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INSTITUTION SUBSCRIPTIONS

A matter dealt with by the Royal Commission on the Taxation of Profits and Income that will interest professional engineers is the anomalous position of employees in regard to allowances for subscriptions to professional associations. This matter was raised in the House of Commons during the debates on last year's Finance Bill, when it was pointed out that, although corporate membership of a professional association is frequently a condition of appointment to a post in the Government service, the Treasury refuse to state that it is a condition of employment, and therefore the Inspector of Taxes can do no other than refuse to allow the subscription as an expense.

This appararent nonsense arises out of the differing rules that define deductible expenses under Schedule D, which deals with self-employed persons or business corporations, and Schedule E, which covers employees. Under Schedule D rules, if the expense is "wholly and exclusively laid out or expended for the purpose of the trade, profession or vocation" it is allowed. Under Schedule E the expense must be "wholly, exclusively and *necessarily*" incurred. In practice, whether or not the expense has been necessarily incurred can only be determined by the employer.

When this matter was debated last year the Government said that they were awaiting the Report of the Royal Commission. The Royal Commission has now recognised the anomaly of the present situation. The majority of the Commission recommend modifying the present rules so as to allow deduction of "all expenses reasonably incurred for the appropriate performance of the duties of the office or employment," which would presumably include subscriptions to professional associations. The minority, however, consider that this relaxation would merely open the way for the sort of tax avoidance and disputes between the Revenue and the taxpayer as now occur in the case of Schedule E claims, with little net gain in equity as between taxpayers. They propose instead a greater degree of differentiation between earned and unearned incomes.

Whatever decision the Government takes on these alternative proposals, there can be no objection to legislation (if that is necessary) which clearly defines a particular type of allowable expense that may be incurred by an employed taxpayer. In view of the rapid changes taking place in modern technology and the need for those engaged in research, design and production to keep abreast of the new and, in many cases, revolutionary ideas, it is in the national interest to encourage those engaged in the public service or in private industry to remain members of their appropriate associations and learned societies.

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REWARDS AND DISCIPLINE

Industrial relations and the sharing of national income figured prominently in the Debate on the Address in reply to the Speech of H. M. the Queen on Thursday of last week. In his answer on behalf of the Government to the Opposition's criticisms, Mr. R. A. Butler, the Chancellor of the Exchequer, made reference to the

impact of the present strike wave on the country's economy and stressed the danger to the export trade of advancing costs, which were likely to arise as a result of it. He said that it would be wrong if foreign observers thought that the effects of the railway strike had been greater than they had been. For example, it should be recognised that coal production had been maintained and that the supply of coal to industry had been better than had been thought likely. At the same time, the severe test of international competition could not be escaped by distorting the true level of home costs.

The Opposition had moved an amendment to the Address, regretting that the measures set forth in the Queen's Speech were not calculated to achieve full employment, stable prices, peace in industry, an adequate surplus in oversea payments, or a more equitable distribution of wealth. Mr. Hugh Gaitskell, in support of the amendment, said that everyone should wish to see a substantial surplus in the balance of payments, stable prices, industrial peace, rising productivity and a higher standard of living. The Opposition, however, disagreed with the Government's policy to achieve those aims. The Prime Minister might be pinning his hopes on co-partnership and profit-sharing. However, the Opposition were not against such schemes if employees wanted them.

Mr. Butler said that the Government's efforts had been extremely successful in restoring prosperity and liberty, by doing away with rationing and restrictions, increasing food supplies and protecting employment. They believed in a policy of expansion, but this policy could only be successful if accompanied by discipline and incentives in industry. The Government would continue to employ both aspects as they were needed. Their object was to place more responsibility on the individual and less on the State. They believed in a working free-enterprise system. The Government were also in favour of profit-sharing, although they realised its limitations, and they sought to find the best possible method of conducting industry. With respect to profit-sharing, Mr. Butler said that the Inland Revenue would help any firm which might wish to bring in a scheme likely to help its employees, but he did not indicate what form the help would take.

In the ensuing debate, a Labour Member referred to profit-sharing and co-partnership schemes as "crumbs allowed to fall from directors' tables," but many will feel that "extra slices," to be added to the substantial loaves of wages and earnings, would be more apt.

* * *

INSTRUMENTS

Instrumentation and controls are important in almost every branch of industry since they serve not only as a basis for studying industrial processes, but also as a means of establishing and maintaining optimum working conditions. Thus, with their aid, increased and cheaper production of higher and more consistent quality may be achieved with less wear and tear on plant. An opportunity to see the latest additions and improvements in this field will be provided by the British Instrument Industries' Exhibition which is to be held at Earls Court from Tuesday June 28, to Saturday, July 9. A survey of some of the items to be exhibited appears on page 795 of this issue.

At the exhibition, which is organised by F. W. Bridges and Sons Limited, and sponsored by five manufacturers' associations, will be shown scientific and electrical instruments, industrial meters, automatic controls, scientific glassware, drawing-office equipment and other associated products. Particular subjects to be covered include gas and liquid analysis by vapour phase chromatography; flaw detection; process control by means of indicators, recorders and self-setting valves; furnace and boiler control; electronic computing; spectrometry; and measuring methods of many kinds.

During the course of the exhibition a number of lectures and conferences are to take place, and among the speakers will be Mr. R. Clare, B.Sc., A.M.Inst.F. of the National Industrial Fuel Efficiency Service, who will discuss "Instrumentation as an Aid to Fuel Efficiency"; and Mr. Denis Taylor, M.Sc., Ph.D., M.I.E.E. of the Atomic Energy Research Establishment, Harwell, whose subject will be "Instrumentation and Nuclear Energy." Other topics proposed are "Future Applications of Digital Computers," to be covered by Mr. M. McGee Rose, M.A., A.M.I.E.E., of Ferranti Limited; and "Photocopying and Reproducing in Industry," which will be dealt with by several speakers.

It may be of interest to note that concurrently with this exhibition the 10th International Printing Machinery and Allied Trades' Exhibition is being held at Olympia, and in view of the growing use of instrumentation in the printing industry, particularly with regard to temperature control, visitors to one exhibition may wish to visit the other and conversely.

* * *

NOT ENOUGH DRAUGHTSMEN

The present shortage of draughtsmen is a matter for general concern in the engineering world. It may be due, in part, to the great demands that are being made on drawing offices as a result of new developments, but it is also undoubtedly due to the gradual decline that has taken place in the status and recognition accorded to draughtsmen.

This is wrong. The professional institutions have strengthened their position, and with it the status of their members; and the engineering trade unions, by different methods, have acquired formidable power. Draughtsmen as a class do not fall naturally into either of these groups (though some are members of a trade union and some are members of a professional institution). But there is no questioning the value, as well as the skill and scientific content, of their work. They enjoy a sense of creative satisfaction that is denied to many in engineering, and on their ability to interpret conflicting requirements in design other departments lean heavily. These facts are recognised and re-stated by Mr. H. Clausen, in an article in this issue. Positive action may be needed to reduce the shortage of draughtsmen, or it may be that the exceptionally high salaries which some are being paid for urgent and vital work will correct the situation automatically. But there is too much inertia in that remedy. It would be far better to realise that the proportion of people who work at desks and drawing boards is irrevocably rising, and that the general conception of the type of man who can be recruited from the shop floor needs to be re-adjusted.

* * *

THERMAL-BARRIER WIND TUNNEL

Recently, at the Whitley guided-missile plant of Sir W. G. Armstrong Whitworth Aircraft, Limited, Lord Brabazon of Tara inaugurated the Hawker Siddeley Group's new supersonic wind tunnel. It is the country's first large-scale installation of this kind designed and built entirely under private enterprise and capable of providing a continuous flow at three times the speed of sound. Developed at a cost of £200,000, it will be used for testing rockets, advanced jet engines, guided missiles and aircraft flying at speeds up to the 2,000-m.p.h. range, and the first part of a description of the tunnel appears in this issue on page 797.

Of particular interest is the choice of Mach 3 as the upper air-speed limit. Mach 3 is within the region of the "heat" or "thermal barrier," so called because at these high speeds the heat generated by motion through the air is sufficient to distort aircraft structures and to make unusable "air-breathing" engines of any form known to-day.

The tunnel occupies more than 30,000 sq. ft. of floor space, scoops up 2,400 gallons per minute from the River Sowe for cooling water, compresses 1·6 tons of air per minute and is driven by a 10,000-h.p. motor. The working section, however, is necessarily small. Models up to 16 in. long can be tested in conditions which simulate an unbounded medium, while results will be interpreted at the same time by means of electronic computers. With the main tunnel are a small intermittent transonic tunnel and a 5 ft. by 4 ft. low-speed tunnel.

The design and construction of the complete installation has been carried out under the direction of Dr. William Frank Hilton, the company's chief aerodynamicist. Testing time is to be let to the Government and industry in general on a scale calculated to make the tunnel economically self-supporting.

* * *

IRON FOUNDRY BUSINESS

Ironfounding is an old but by no means backward industry. There has been much ill-considered criticism of working conditions, but as the Council of Ironfoundry Associations showed in their booklet "Years of Endeavour" (a study of achievement between 1947 and 1954), this was easily refuted. Output is rising. As the statistical appendix to the 1954 annual report of the chairman and the executive committee of the Council shows, the output of 3·7 million tons was nearly 3 per cent. higher than in 1953. Details are not published of a survey made by the Joint Iron Council forecasting demand up to 1960, but on the basis of their findings the Iron and Steel Board have published a report which refers to an output of 4 million tons in 1958. This must necessarily assume a high degree of prosperity in the engineering industry.

The largest increase in consumption of castings is taking place in the motor-vehicle industry (16·5 per cent. in 1954). Motor vehicles, however, account for only 8·5 per cent. of the total output of iron castings in the United Kingdom, compared with 39·7 per cent. in engineering and general jobbing (where consumption rose by the more modest figure of 3·8 per cent. in 1954). Shortages of raw material should not prevent the realisation of higher output, although there have been difficulties over the supply of low-phosphorous and low-silicon manganese haematite pig irons. Both the Iron and Steel Board and the Joint Iron Council have given special consideration to the future demand for these. The British Coking Industry Association have accepted the forecasts of the foundry industry and expect to be able to meet their demand for coke. The labour supply is improving. In the twelve months to January 1, 1955, the number employed in the industry increased by 1,200 to 133,300.

Recruitment and training are receiving considerable attention; the Recruitment, Training and Education Committee of the Council arranged for an experimental course for foundry supervisors to be held at the National Foundry College in April. It is intended to hold a course for top management later in the year. A survey has been made of the training schemes of nearly 100 ironfounding companies, and the backing of grants from the Government Conditional Aid Funds is enabling training to be put on a sound footing. The industry is also active in its research. The affiliated technical associations of the Council, the British Cast Iron Research Association and the Institute of British Foundrymen have been working on a wide range of subjects, including dust and atmospheric problems, the design of castings and the simplification of foundry operation.

A forum for the discussion of problems met by all foundrymen will be provided by the Twenty-Second International Foundry Congress, which is being held in London from Sunday, June 19 to Saturday, June 25. The Congress has been organised by the Institute of British Foundrymen under the auspices of the International Committee of Foundry Technical Associations and a number of papers are being presented.

THE AUTOMATIC FACTORY: WHAT IT MEANS

The conference organised by the Institution of Production Engineers under the title "The Automatic Factory—What Does It Mean?", if it achieved nothing else, demonstrated to the world the great interest that exists in British industry in the general subject for which the Americans have coined the name of "automation." Over 1,100 delegates attended the conference at Margate last week-end, from a great variety of industries and from several European countries; three papers were read in plenary session; 18 papers were discussed in groups which reported on the last day to the whole conference; there was a film show and an impressive display of automatic equipment ranging from inspection devices to electronic computers. The papers were generally of a high standard; those which dealt with technical aspects of the problem covered process industries, mechanical industries, inspection and office work.

Perhaps the most significant feature of the conference was the awareness of nearly all those who took part of the importance of the economic and sociological aspects of the changes taking place in industry with the introduction of the new methods. Almost every paper made some reference to these questions, if only to deal with the charge that the changes will create unemployment, and there were separate papers on the economic and social problems, on the problems for management, on the attitude of the trade unions and on education. This awareness did not, however, lead to the kind of exaggerated technocratic views which have been expressed by some engineers in the United States. As Sir Walter Puckey, to whose conception of the idea the conference owed much, said at the end, there had been an impressive sense of balance in the conference. This may have been because the delegates had a true understanding of the pace at which technical change can affect society or because of a reasonable wariness in face of the untried; but it may equally be due to a reluctance to accept new ideas in production unless they are proved up to the hilt. It was suggested that in the United States production engineers, because they have themselves worked at some time on research and development, are more willing to accept "half-baked" ideas and to assist in getting them going in production.

In his eminently common-sense paper, Mr. Frank Woollard described the long history of automatic operation, particularly in such process industries as paper-making, printing, flour-milling, chemical and food production, as well as on individual metal-working machines. In his view, what is new is the extension of automatic operation to the hard, heavy, awkward and unyielding shapes of those components used in industries which are based on engineering practice; the adoption of controls—electronic or otherwise—and the institution of feed-back apparatus and servo-mechanisms, to ensure that accuracy is maintained within pre-determined limits.

In a paper which combined the technological and sociological in a brilliant narrative, but which avoided the pseudo-philosophical jargon of some writers on this subject, Lord Halsbury named the four components which enter into the concept of automation as transfer machining, control engineering, communication engineering and mechanical assembly. Among the advantages of automation that were brought out by speakers, in addition to the generally recognised saving of labour costs, were increased safety for operators, closer control of quality, fuller machine utilisation, saving of material and lower inventory of work in progress.

PROCESS INDUSTRIES

In spite of the degree to which automatic control has been applied in the process industries, Mr. A. J. Young, of I.C.I., thought that the engineering industries had profited more than the chemical industry from the techniques and equipment, such as servo-mechanisms, which developed for the Services during the war, although the chemical industry was more likely to be the first to achieve the fully automatic factory which could be started and stopped by the push of a button and would operate without human intervention at maximum efficiency. Because the information required to calculate the dynamic characteristics of most chemical processes and plants has not yet become available, application of fundamental control-system theory to the design of chemical process control systems is not in general possible at present. The inability to calculate process and plant characteristics is probably the major impediment to the design of a completely automatic chemical factory.

Even if some of the separate plants can be made fully automatic in the near future, it is unlikely that the large and complex factories in which they are to-day so frequently grouped could be designed as a completely automatic unit. Present practice still generally involves manual adjustments to the controllers whenever there are large changes in operating conditions. These adjustments are: (1) to the desired value settings, and (2) to the controller action. A more advanced system employs linkage between two or more controllers, with separate functions and measuring units, forming a simple multi-loop or "integrated" system. The trend of practice is towards a development of this system by increasing the linkage of the individual controllers and putting them under the control of a single "master controller." This master controller would operate on a continuous measurement of product composition and adjust the desired values of all the subsidiary controllers to maintain the composition constant, thus eliminating the need for routine laboratory analysis of the product and the delay between the analysis and the readjustment of the controllers.

Alternatively, the master controller could be designed to receive all the measurements taken on the plant, compute the necessary action and send out signals for the adjustment of the values. In doing so it would take into account changes in plant characteristics so as to preserve a consistent product composition. Such a controller must be a relatively simple computer of great reliability and consistency, designed for continuous operation on a single problem. The first automatic chemical factory may well be designed for manufacturing a product that could be made in no other way or in order to be able to arrive by experiment at the best operating conditions in a few weeks instead of—as at present—in years.

In another paper Mr. I. McCallum, of Esso Petroleum, Limited, described an oil refinery which consists of a multiplicity of processing units, each separately, automatically controlled. He said that the day is far distant when a complete refinery can be operated from a single control room.

WEIGHING AND MIXING

Mr. P. J. Bourgeois, of Oerlikon Machine Tool Works, described the application of varying degrees of automatic control to the weighing and mixing of raw materials. Basically, this is achieved by the use of a formula template from which orders are electrically transmitted to the scales, hoppers, worm conveyors, vibration feeders, conveyor belts, and so on. Any pre-determined number of batches can be made up to the same formula. The advantages of this system are the elimination of human errors in composition of substances sent for processing; the safeguarding of secret formulae; and the abolition of harmful atmospheric conditions in the plant.

ROTARY TABLE MACHINES

The series of papers dealing with the applications of automation in the mechanical field included two fairly general ones on motor-car factories using automatic transfer machines—one by Mr. P. Bezier, of Regie Nationale de l'Usine Renault, and one by Mr. H. J. Graves, of the Austin Motor Company; two papers on automatic control of machine tools—by Mr. J. H. Stokes, of the British Thomson-Houston Company, and by Mr. D. T. N. Williamson, of Ferranti, Limited; and one on automatic linking devices by Mr. J. A. Hunt and Mr. J. B. Jay, of the Hymatic Engineering Company.

Mr. Bezier described rotary-table machines where the components are moved in a horizontal direction on a horizontal plane; drum transfer machines where circular movement takes place on the vertical plane; and machines where movement is linear, known either as "transfer" or "processing" machines. Such machines are mainly constructed at Renault with interchangeable elements. They consist of machining units fitted as required with multi-heads, with bush plates for such tools as drills and reamers, with tool-holders and with automatic transfer mechanisms, thus ensuring the movement of components from one work station to another. While it is true that the size and cost of these machines restricts their use to large mass-production factories, it is not the case that their initial cost or maintenance cost, per unit of output, is higher than with separate standard machines. In the Renault works, in a department employing 3,400 on making the mechanical parts for 4-h.p. cars, the maintenance team comprises 133 people, of whom 30 are particularly assigned to 200 special machines. This is to be compared with the 1,000 standard machines which would be needed to replace the special machines, involving a maintenance staff of 170.

MOVEMENT OF MATERIAL

In Mr. Graves's view it is perhaps in the movement of material through the factory that the greatest benefit from the use of automatic devices will be obtained. He described what has been done in the Austin motor-car works to handle components from their entry into the works until their final assembly into the car. He also described the progress made in the automatic assembly of small components such as ball bearings, petrol pumps and commutators, and in the use of transfer sheet-metal and forging presses. The number of stations in a transfer machine is mainly limited by the need to minimise loss due to mechanical breakdown. There are still parts which cannot at present be produced on transfer or rotary machines and which will continue to be manufactured on existing machines. These will have to be dealt with by introducing automatic means of loading the components into a machine and of transferring it from one machine to another. This can be achieved by co-operation between the machine tool and conveyor manufacturers and production engineers trained in automation methods. In this connection it was surprising that the machine tool manufacturers were not better represented and had no paper to present to the conference. It was said by some speakers that there was a resistance among machine tool designers in this country to adapt their designs for automatic control, but that such control could not be successfully added to a machine after it had been designed. The need was also emphasised for great rigidity in machine parts if errors due to deformation were not to be introduced into the control system.

AUTOMATIC MACHINING

While it is true that the use of transfer machines will be restricted to large companies operating on a scale which make the capital expenditure involved worth while, there are signs of new developments which may restore the balance in favour of the small manufacturer and even assist the jobbing shop. The most interesting paper from this point of view was that of Mr. Williamson on computer-controlled machine tools,

which was amplified by a demonstration by Ferranti, Limited. The system described is almost a revolution in machining methods, making a complete break with methods which require at least a first master to be produced by hand. It is capable of machining a surface directly from the equation of that surface and also of producing any second-degree curve through three specified points and of forming approximations.

The method comprises the use of a digital computer which can be instructed to perform a sequence of movements and given dimensions of the points of change by means of punched teleprinter tape. The computer records the required track of the tool on magnetic tape at a speed sufficiently high to enable 50 machines to be controlled by one computer. The tape is then used to control the machine tool by means of highly accurate servo-mechanisms, in conjunction with a digital measuring system of great accuracy utilising an optical grating independent of lead screws.* By these methods a three-dimensional cam for a turbine-blade miller, taking three weeks to make by present methods, can be planned, computed and machined in four hours. The two halves of a milled-block waveguide structure, machined in light alloy, could be completed in 40 minutes instead of taking a skilled machinist two weeks.

This system, like many others in the automatic-control field, is most valuable when the time taken by the human machine operator in "perception" and "reasoning" is high compared with the time taken in "motor" action. This is typical of tool-making and prototype manufacture. It is, therefore, of great use where there is a shortage of skilled machinists. It also was said that, for general use, the computers could be made with built-in programmes capable of contouring any curve which may be specified by a second-degree equation and, thereafter, the construction of a planning sheet would be within the capabilities of any planning engineer of the craftsman type.[1] From the planning sheet the data would be transferred by a typist to the punched tape which is fed into the computer. For small firms for whom the cost of a computer would be uneconomic, there could be established contract computing centres, to which they could send their planning sheets and receive in return magnetic control tapes.

INSPECTION

In an extremely interesting paper Mr. J. A. Sargrove and Mr. Peter Huggins, of Sargrove Electronics Limited, dealt with electronic methods of inspection. They divided faults occurring in production, as discernible by automatic inspection, into three main categories: (1) Those of a *sporadic* nature caused by occasional random phenomena; (2) those of a *repetitive* nature due to a continual occurrence of a fault that has developed; (3) those of a *trenditional* nature due to a gradual accumulation of errors.

For all three cateories automatic answers can be devised, but it is in Group 3 that the automatic inspection device can break new ground. It is in this category that "information" is abstracted from the inspection devices and employed as a means of controlling the product either by direct correction or by delayed correction. As a further step, equipment can be arranged to remember a partial fault and hand it forward to the next operative machine which is designed to correct what has previously been detected. These devices are capable of statistical calculation, using averages and so forth, and of "remembering" and "forgetting" information received. They obviate the errors of human inspection due to the fallibility of human beings when under the hypnotic effects of endless repetitive examination of a series of similar articles, most of them correct. They also help to minimise the variations either side of normal of the product (narrowing the base of the statistician's "normal" distribution curve) and so saving raw material and improving the quality of the product.

In his paper on the automatic office Mr. D. W. Hooper, of the National Coal Board, dealt with the changes that will be needed in office routines and techniques as the use of computers grows, and in a number of other papers there were references to the use of computers for speeding up information for management, particularly for the control of sales, production and stocks.

SOCIAL CONSEQUENCES

In answer to the question whether these new devices would create serious economic and social disturbances there was almost universal agreement that this need not be so; although the anxiety on this score was perhaps reflected in the fact that nearly half the delegates attended the group discussion opened by Mr. E. Fletcher of the Trades Union Congress on "How will Trades Unions React?"

In general the feeling was that the pace of introduction of automation would not be so rapid as to be unmanageable, and this for a number of reasons. There is, as Professor B. R. Williams pointed out, the natural indolence of many firms in this country and the fears of management that it will bring an excessive level of overhead cost or unmanageable technical problems. The strongest impediment, however, will be the shortage of engineers and scientists to design automatic plants, and of technicians and skilled craftsmen capable of setting them up and maintaining them.

EDUCATION

This problem of educational provision applies equally to management for, as Mr. M. Seaman, of British Oxygen Engineering Limited, who dealt with problems of the board-room, and Mr. F. Garner of Joseph Lucas, Limited, with those of the manager, pointed out, there will arise serious new problems of staff co-ordination, along with new techniques in the handling of information and of planning, if the full benefits are to be obtained. The difficulty of co-ordinating the great variety of expert knowledge that must be utilised, if automatically controlled processes are to be effectively used, was demonstrated by the experienced engineers who attempted to report the group discussions to the conference. Mr. E. W. Hancock, of Humber Limited, frankly confessed himself lost, but admitted that the young engineers who had attended the conference in such encouraging numbers would no doubt acquire the necessary knowledge.

Apart from Mr. Fletcher, the only British trade union officially represented was the Electrical Trades Union, although there were a number of delegates from French trade unions. Mr. Fletcher said that British trade unions have not opposed developments of automatic production and control, but even welcomed them as increasing the kitty out of which they have to extract higher wages.

The basic reason why this has been so is the overall condition of full employment. This is a pre-requisite for full, positive and detailed trade union participation in industrial development. Differences of opinion are bound to arise on the national level as well as within individual firms, particularly about the workpeople's share in increased productivity and how far it should be taken in the form of cash or leisure or in the form of social benefits. Unions would force attention to problems of redundancy and enforced changes of occupation and status and would need to be satisfied on the effectiveness of schemes of re-training and to participate in them.

SHORTAGE OF SKILLED STAFF

The general view that emerged from the conference was that the shortage of trained staff was likely to keep the development of automation in this country well below the pace at which it could be economically and sociologically absorbed. Unemployment was not likely to be created, for new kinds of skill would replace the old; and new industries, particularly those catering for personal consumption and leisure, would grow as the national income rose. Moreover, the speed with which statistical information could be gathered and evaluated with electronic computers would assist governments to take action in time to deal with overall changes in economic activity.

One serious problem is, however, beginning to appear. It arises out of the differing conditions of those in the industries to which automation can be applied and of those in trades that cannot take advantage of it. Mr. Woollard drew attention to tensions that could be set up by differences in the length of the working week and in the remuneration between, for instance, the automobile workers of Birmingham and Coventry, and those working in the engineering establishments of the North East Coast. Lord Halsbury took this problem even deeper. While he foresaw the ending of repetitive drudgery, leaving to hard physical labour mainly the creative tasks such as construction work, forestry and oil drilling, he feared that there was one class of labour who would be by-passed in the upgrading process, namely, those engaged in the dirtiest, hardest and most dangerous work, such as coal miners and stevedores. Technology might leave us with a cross-grained minority of those on whom had fallen the world's residual drudgery in a majority world of engineers, administrators, scientists and artists; cross-grained because psychologically isolated from, and therefore at cross purposes with, the rest of the community. Anyone who has studied the sociological background to strikes in the coal mines or the docks can appreciate how justified Lord Halsbury's anxiety is. In its success in bringing out problems of this nature, as well as in projecting present scientific developments into the future, the conference was extremely valuable.

* * *

Letters to the Editor

CATHODIC PROTECTION OF SHIPS

SIR, On page 690 of your issue of June 3, in the discussion of the paper on "The Cathodic Protection of Ships," by L. T. Carter and J. T. Crennell, you kindly quote a paper published by myself in 1929 and stated to be printed in the *Journal of the Chemical Society*. The journal in which it appeared was the *Transactions* of the (American) Electrochemical Society, vol. 55, page 243. The paper showed that drops of salt water placed on painted steel surfaces often develop traces of alkali due to the cathodic reaction; this alkali may soften and/or loosen certain paints, so that the coat sometimes peels off, leaving the steel unprotected. For marine situations—particularly where cathodic protection is to be applied—a paint vehicle which resists both alkaline softening and alkaline peeling is advisable.

Yours faithfully,
ULICK R. EVANS.

Department of Metallurgy,
Cambridge University.
June 17, 1955.

* * *

LIGNUM VITAE

SIR, I am compiling a history of the use of lignum vitae, and while it is known that it was used medicinally as early as 1508 and for turnery in this country about 1640, I would like to have some information on its use as an engineering material, and in particular its introduction as a stern-tube bush in ships.

If any of your readers have any information I would very much appreciate it. Any help in this matter would be duly acknowledged.

Yours faithfully,
D. B. IRVIN.

Irvin and Sellers, Limited,
Derby-road,
Liverpool, 20.
June 16, 1955.

* See ENGINEERING, vol. 177, pages 263 and 766.

ATOMIC POWER

NUCLEAR REACTORS FOR ELECTRICITY PRODUCTION

During the Debate on the Address in the House of Commons, Mr. Geoffrey Lloyd, the Minister of Fuel and Power, reported last week that the United Kingdom Atomic Energy Authority had announced new additions to Britain's atomic programme. Six more atomic reactors, designed to produce both electric power and fissile material for military purposes, were to be built, and would be of the same kind as those now being constructed at Calder Hall. These were additional to those proposed in the £300 million programme announced by the Government in February. Mr. Lloyd also discussed the need for skilled personnel and referred to the problems of siting. " In recent months," he said, " I have had a queue of hon. Members asking me whether they can have atomic power stations in their constituencies." In addition, he reported that four main industrial groups had now been formed for the purpose of developing this industry. Orders for equipment, plant and civil-engineering works for nuclear-power stations have been placed with various engineering companies, several of which have announced their plans with regard to these undertakings.

NUCLEAR POWER PLANT COMPANY

Recently Sir Claude D. Gibb, C.B.E., D.Sc., F.R.S., managing director of C. A. Parsons and Company, Limited, Newcastle-upon-Tyne, 6, stated in a letter to the firm's employees that his company and seven others had agreed to collaborate on nuclear-engineering projects and had formed a special organisation for this work—the Nuclear Power Plant Company, Limited—with its design headquarters at Booths Hall, Knutsford, Cheshire. The seven other firms taking part in the scheme are A. Reyrolle and Company; Head, Wrightson and Company; Sir Robert McAlpine and Sons; Whessoe; Strachan and Henshaw; Alex. Findlay and Company; and Clarke, Chapman and Company; who, through the new organisation, will co-operate with the production division at Risley of the Atomic Energy Authority. This division is responsible for designing and constructing advanced experimental reactors.

Sir Claude Gibb also announced that orders for machine tools costing about one million pounds had been placed by C. A. Parsons and Company, for a proposed new factory at Newcastle-upon-Tyne which would be concerned with the construction of nuclear-energy plants. This works, to be built by C. A. Parsons in association with the other seven firms, would cost approximately three million pounds.

In addition, he observed that, although at one time it had not been known whether turbo-generators would be required in the atomic age, the need for plant of this kind in the foreseeable future was now certain. Uranium or thorium would be the primary fuel, replacing coal or oil, and the heat generated during nuclear fission would be used to raise steam for driving turbines.

PLANT FOR FAST-BREEDER STATION

As announced by the Government in February this year, the first " fast-breeder " reactor to be built in the United Kingdom is to be sited at Dounreay, and would be a full-scale experimental model capable of producing power. Sir John Cockcroft, Director of the Atomic Energy Research Establishment has suggested that this type of reactor is " an engineer's nightmare " because of the quantity of heat that has to be extracted from a small volume, and because bombardment with neutrons is very intense.*

A major contract in connection with the Dounreay nuclear power station has been entrusted to John Thompson Limited, Ettingshall, Wolverhampton, who, in co-operation with the United Kingdom Atomic Energy Authority, will be responsible for developing methods of fabrication for liquid-metal circuits; the design of steam and water equipment; and the manufacture of fusion-welded stainless-steel vessels, primary and secondary heat exchangers, boiler drums, valves, instrumentation, the feed-water treatment plant and other associated equipment.

This work is quite separate from that which the company is carrying out in collaboration with Associated Electrical Industries Limited, in the development of gas-cooled thermal-reactor plant such as will be used in the first commercial nuclear power stations. The fast-breeder type of reactor will effect better utilisation of nuclear fuel than any of the earlier gas-cooled or liquid-cooled thermal reactors, but, although construction of commercial generating stations based on the Calder Hall experiment might commence in about 1957, and operation begin in 1961, it is not anticipated that a commercial station of fast-reactor design can be tested in operation until 1965 at the earliest.

SITING

However, while these developments are proceeding, it is necessary to consider the siting of future stations. The Minister of Fuel and Power has stated that rather different factors enter into the choice of sites for atomic power stations than for ordinary power stations. They do not, for example, require to be near coalfields; but, although they do not need elaborate railway sidings for delivery of coal, large quantities of cooling water are necessary and coastal or river sites are thus likely to prove more suitable. Another consideration is the massive weight of nuclear reactors, and it will be essential therefore to select locations where the subsoil is capable of bearing them. No high chimneys will be required and the problem of air pollution would scarcely arise.

Mr. Lloyd also referred to atomic energy courses for industrial representatives recently started by the Authority; the urgent need for skilled personnel; and the part being played by the three senior engineering institutions in the development of nuclear industry.

* 61st James Forest Lecture, read before the Institution of Civil Engineers on Tuesday, May 24.

ATOMIC "WASTE"

APPLYING FISSION PRODUCTS TO INDUSTRIAL USE

The food, radio, pharmaceutical and plastics industries are among those likely to benefit from the activities of a new research and advice organisation formed by the United Kingdom Atomic Energy Authority at Harwell. Known as the Technological Irradiation Group, it will assist industry to make full use of the large supplies of radioactive materials which will become available as a result of the expanding atomic-energy programme, and will also carry out research on the applications of radiation. It will in addition, be able to place at the disposal of industry equipment and materials for the same purpose. Besides fission products the group will use Van de Graaf machines and strong radio-active isotope sources, which will be produced in reactors under construction at Harwell.

When the nucleus of a uranium atom undergoes fission in a nuclear reactor the nucleus is split into two radioactive fragments, and these provide radiation which can be used for many purposes in industry and medicine. Stocks of such fission products have already been produced by the nuclear reactors at Windscale, and as the British programme for producing power from nuclear energy is implemented, radiation hundreds of times greater than could be obtained from the world's total radium resources will become available for useful purposes.

One way of utilising the radiation from fission products is to use—without any processing—fuel rods which have been withdrawn from the reactor. Normally fuel elements are stored for a time to allow some of the radiation to die away, and during this storage period they can be used as radiation sources. After this the fuel elements are processed to recover the original uranium and the plutonium produced from it in the reactor. Residual liquors from this process contain the fission products and they can be evaporated to give the " gross fission products " which serve as a source of radiation; for some purposes, however, it may be necessary to isolate particular products such as caesium 137.

PLASTICS

It has already been found that the radiations can affect polythene to make it more resistant to heat. This modification of polythene would be of particular interest in the manufacture of special cables where its resistance to heat would enable it to be used at higher ratings and at higher temperatures. Radiation can also be used to vulcanise rubbers; this is particularly effective in the case of the rubbers made from silicone (see page 789 of this issue). The use of radiation also enables vulcanisation, which may take several hours, to be speeded up considerably.

In the chemical industry it has been found that processes which require high temperatures and pressures have, when used in conjunction with radiation, taken place under less onerous conditions with a corresponding saving in plant costs. In addition, by using radiation, it has been found possible to produce many plastics which could not be made by conventional methods. Chemical processes can often be speeded up if radiation is used, for example, in the preparation of the insecticide " gammexane." In manufacturing drugs such as hormones, radiation may also be useful.

TRANSISTORS AND STERILISATION

Among the physical effects produced by radiation is the improvement of the properties of transistors. In particular the shut-down time of a transistor is decreased by radiation and hence the speed of working of a computer, for example, would be increased.

The radiation from fission products can also be used to sterilise materials; this sterilisation does not involve any significant rise in temperature and so offers considerable advantages. There is therefore an obvious future for the use of radiation in the sterilisation of pharmaceuticals including antibiotics such as penicillin and streptomycin where heating is not permissible. Fresh vegetables and meat have also been sterilised in this way. It is possible that widespread use of radiation sterilisation may replace refrigeration as a means of keeping food fresh.

As has already been mentioned, separated fission products such as caesium 137 have particular applications; for example compact caesium sources, equivalent in strength to thousands of grams of radium, are envisaged for use in hospitals. The radiations from these large sources of caesium would be used in place of the radiation from radium or large X-ray machines in the treatment of disease. Another possible use of radiations is to sterilise human bone required for transplanting. Likewise, sections of artery required for grafting could also be preserved for subsequent use by radiation.

AGRICULTURE

Among the possible applications in agriculture is the use of radiation to induce mutations in seeds to produce new species of plants, such as barley with short stalks or other desirable qualities. Spore activity may also be reduced by radiation and so excessive respiration in cereals could be prevented. It may also be possible to destroy insect pests in materials such as grain.

PERSONAL

The University of Cambridge has conferred the honorary degree of Doctor of Laws on SIR CHARLES TENNYSON, C.M.G., secretary of the Dunlop Rubber Co. Ltd., from 1928 until 1948.

LORD COLERAINE, P.C., who is probably better known as Mr. Richard Law, has been appointed chairman of the National Youth Employment Council, by the Minister of Labour and National Service, in succession to LORD PIERCY, who has resigned.

MR. H. C. VAN DE VELDE, who has held senior executive posts in Marconi's Wireless Telegraph Co. Ltd., and the Marconi International Marine Communication Co. Ltd., for 36 years, is to relinquish his present position as deputy to the managing director of the Marconi Marine Co. on June 30. MR. R. FERGUSON, the general manager, will, in future, extend the scope of his responsibility for the company's affairs as senior executive. Mr. Van de Velde's services will still be available in a consultative capacity.

BRIGADIER G. A. T. PRITCHARD, C.B.E., chief engineer, headquarters, Southern Command, has been appointed director of fortifications and works, War Office, with effect from November, 1955.

Seven appointments have been made to the boards of directors of three of the subsidiary companies of KELVIN AND HUGHES LTD. The new directors, who will continue their day-to-day duties within the organisation, are as follows : To the board of Kelvin and Hughes (Aviation) Ltd., MR. F. W. BATES, who was recently appointed to the board of the parent company; MR. R. W. DUNN, B.A., A.F.R.Ae.S., who is chief engineer, aircraft instruments; MR. D. H. PERKINS, M.B.E., works manager, Kelvin Hughes Works, Basingstoke, Hampshire, and MR. G. WIKKENHAUSER, M.B.E., chief development engineer at the company's Barkingside factory, London. To the board of Kelvin and Hughes (Industrial) Ltd., MR. P. J. A. TURNER, A.M.I.E.E., who is chief engineer at the company's Glasgow factory. To the board of Kelvin and Hughes (Marine) Ltd., MR. H. R. WHITFIELD, M.I.E.E., chief radar engineer, and MR. R. M. STEPHENSON, overseas sales manager to Kelvin and Hughes (Marine) Ltd.

MR. C. G. F. PRITCHETT, M.I.E.E., A.C.G.I., has taken over the position of chief engineer to Chloride Batteries Ltd., Exide Works, Clifton Junction, Swinton, Manchester, in succession to the late MR. C. P. LOCKTON. Mr. Pritchett became a director of the firm in May, 1952.

MR. THOMAS HARTLEY, general works manager, British Tyre and Rubber Group, MR. S. G. DEAVES, sales manager, industrial rubber products division, and DR. W. D. SCOTT, personal assistant to the managing director, have been elected directors of the British Tyre and Rubber Co. Ltd., Herga House, Vincent-square, London, S.W.1.

MR. R. J. PYCOCK, until recently chief production engineer at the factory of Hoover Ltd., High Wycombe, Buckinghamshire, has been appointed technical superintendent of the factory of Hoover (Industries) Pty., Ltd., Meadowbank, Sydney, Australia. His place as chief production engineer at High Wycombe has been taken by MR. D. HAMLYN.

MR. H. J. GOLLINS has been appointed general manager, British National Electrics Ltd., the domestic-appliance section of Johnson and Phillips Ltd., Charlton, London, S.E.7.

MR. J. WHITEHEAD, a director of the David Brown Corporation Ltd., and general manager of the Tractor Group, has relinquished his directorship of Aston Martin Ltd., and Lagonda Ltd. He will now concentrate on new developments arising from the David Brown acquisition of a controlling interest in HARRISON, MCGREGOR AND GUEST LTD., agricultural engineers, Leigh, Lancashire, announced on page 263 of our issue of March 4. MR. L. V. GALLAGHER has been appointed manager of Harrison, McGregor and Guest Ltd.

BAILIE BRUCE L.-P. RUSSELL, M.I.E.E., engineer and manager for Johnson and Phillips Ltd., in Scotland, has been appointed to serve on the Electricity Consultative Council for the South of Scotland District.

MR. J. E. SPENCE, M.I.Mech.E., until recently export sales manager of B.E.N. Patents Ltd., High Wycombe, Buckinghamshire, has been appointed general sales manager.

MR. FIRCY EVANS has been appointed home sales manager, Brush Electrical Engineering Co. Ltd., Loughborough, Leicestershire, but remains sales director of Hopkinson Electric Co. Ltd., Cardiff.

MR. J. D. CRESSWELL has been appointed chief buyer for the Lilleshall Co. Ltd., St. George's, Oakengates, Shropshire.

COMMERCIAL

LEYLAND MOTORS LTD., Leyland, Lancashire, by acquiring the entire issued capital of SCAMMELL LORRIES LTD., have absorbed this company. As was the case when ALBION MOTORS LTD. were acquired in 1951, however, Scammell Lorries Ltd. will be operated as a wholly-owned subsidiary company under a separate board with MR. W. E. PEARSON continuing as managing director. The firm's products and services will still be available under the trade description " Scammell."

The whole of the issued share capital of HADRILL AND HORSTMANN LTD., manufacturers of reading and adjustable lamps, has been acquired for cash by SIMMS MOTOR UNITS LTD., East Finchley, London, N.2. MR. G. E. LIARDET, chairman and managing director, MR. J. AYRES, a director and general manager, and MR. R. G. SUTTON, secretary, of Simms Motor Units have been appointed to the board of Hadrill and Horstmann, Mr. Liardet as chairman. MR. G. C. T. HADRILL continues as a director and general manager of the company.

FISHER, HUMPHRIES & CO., LTD., manufacturers of farm machinery, have vacated their Atlas Works, Pershore, Worcestershire, and concentrated their activities at their factory in Pottery-lane, Newcastle-upon-Tyne, 1. (Telephone: Newcastle-upon-Tyne 28291.) Orders and inquiries for spares, however, should be addressed to the firm's Pinvin Works, Pershore, Worcestershire. (Telephone: Pershore 253.) MR. K. J. TOWNLEY, A.M.I.E.E., has joined the company as sales manager. MR. F. MEADOWCROFT is now technical manager and MR. C. R. LLOYD is in charge of the spares department at Pinvin Works.

INDUSTRIA (BEARINGS) LTD., sole agents and importers for GEORG MÜLLER, ball-bearing manufacturers, Nuremberg, Germany, have now completed the transfer of their London office and stockroom to 115 Gunnersbury-avenue, Ealing, London, W.5. (Telephone: ACOrn 8847.)

STEEL WOOL FACTORY (LONDON) LTD. is the name of a new organisation established recently at Silverdale-road, Hayes, Middlesex, for the purpose of producing eleven grades of steel wool, to which the registered trade name " Steewo " has been given. (Telephone: Hayes 5275.)

FLEXELLO CASTORS AND WHEELS LTD., Bath-road, Slough Trading Estate, Buckinghamshire, have formed a separate export company, FLEXELLO CASTORS (EXPORT) LTD., to deal exclusively with export business.

A. C. COSSOR LTD., Cossor House, Highbury-grove, London, N.5, have formed a new company, COSSOR INSTRUMENTS LTD., to design and develop new instruments to meet the demands of research and industry. The chairman is LORD BURGHLEY and the other directors are MR. J. S. CLARK, MR. H. CHISHOLM, MR. H. T. SHEPHERD and MR. L. A. WOODHEAD (general manager).

SIMON-CARVES LTD., Cheadle Heath, Stockport, have opened new Indian head offices at Standard Buildings, 32 Dalhousie-square South, Calcutta, 1., under the charge of MR. N. A. ROSS. The existing office at Jamshedpur will continue to be maintained as a site office.

The registered office of the CLIMAX MOLYBDENUM CO. OF EUROPE LTD., 2-3 Crosby-square, London, E.C.3, will be transferred on July 1 to 99 Pinstone-street, Sheffield, 1, to which address all future communications should be forwarded. MR. C. M. LOEB, JNR., and MR. R. L. PRAIN, O.B.E., have relinquished their directorships, the former as from June 3 and the latter as from June 30, and MR. A. H. BUNKER and MR. R. E. WARRINER have been elected to the board. MR. J. CRITCHLEY has been appointed secretary as from July 1, on the resignation of MR. H. L. RICHARDSON.

Increased demand for pit tubs and mine cars have necessitated the opening of a new fabricating and assembly shop of over 11,000 sq. ft. area at the Sheepbridge, Chesterfield, works of SHEEPBRIDGE EQUIPMENT LTD., a subsidiary company of SHEEPBRIDGE ENGINEERING LTD.

THE BIRMINGHAM RESEARCH STATION of the GAS COUNCIL, 1 Grosvenor-place, London, S.W.1, will be known, in future, as the MIDLANDS RESEARCH STATION, as it is now accommodated in new laboratories at Wharf Lane, Solihull, Warwickshire.

THE MAGNETIC EQUIPMENT CO. LTD., Lake Works, Portchester, Hampshire, are now represented in Holland by BERG & BURG, De Ruyterkade 141-142, Amsterdam; in Belgium by WILLY DEPIREUX, Rue Hector Denis 74, Mont-Sur-Marchienne, Charleroi; and in the Republic of Ireland by the MODERN PLANT & APPLIANCE CO., 64 Aungier-street, Dublin.

Under a licence agreement with the NEW YORK AIR BRAKE CO., Cleveland, Ohio, U.S.A., HAMWORTHY ENGINEERING LTD., Fleets Corner, Poole, Dorset, are manufacturing a complete range of Hydreco hydraulic equipment for the British market, including pressure-compensated four-bolt construction gear-type hydraulic pumps and motors and hollow plunger control valves for all types of hydraulic circuits. A separate hydraulics division of Hamworthy Engineering Ltd. has been created to deal exclusively with the manufacture of hydraulic equipment.

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CONTRACTS

Air Liners. K.L.M. Royal Dutch Airlines have placed an order with VICKERS-ARMSTRONGS LTD., Vickers House, Broadway, London, S.W.1, for nine Viscount 800 series propeller-turbine air liners, for delivery in mid-1957. The K.L.M. Viscount 800 type will be designated the Viscount 803. It will have a pay load of 12,000 lb., and a range, with maximum pay load of 600 miles. Accommodation will be available for 53 passengers. The aircraft is propelled by four ROLLS-ROYCE Dart R.Da. 6-type engines of 1,600 s.h.p., and has an all-up weight of 62,000 lb. It has a cruising speed of 318 m.p.h.

A few days after the above order was placed, Vickers-Armstrongs received an order for twelve Viscount 700 D. propeller-turbine air liners from the British Overseas Airways Corporation for delivery in mid-1957. More recently an additional Viscount air liner has been ordered by Fred Olsen Airtransport Ltd., Norway. The company orginally ordered two Viscounts in January, 1954.

Training Aircraft. An order from Indonesia has been received by the DE HAVILLAND AIRCRAFT AND ENGINE COMPANIES for Vampire training aircraft. These are powered by de Havilland Goblin jet engines. Deliveries to Indonesia will take place this autumn.

Turbo-Alternators. A further order for two 200 MW steam turbo-alternators has been awarded to the ENGLISH ELECTRIC CO. LTD., Marconi House, Strand, London, W.C.2, by the Central Electricity Authority. The machines, to be built at the firm's Rugby Works, are to be erected, subject to Ministerial consent, at High Marnham on the River Trent. When completed this power station will have an installed capacity of one million kilowatts generated by five 200 MW turbo-alternators.

Gear-Hobbing Machines. Following negotiations extending over two years, DAVID BROWN MACHINE TOOLS LTD., Sherborne, street, Manchester, have been commissioned to supply one of their M.H. 200 turbine-gear hobbing machines to Ishikawajima Heavy Industries Co. Ltd., shipbuilders, Tokyo, Japan. The order is valued at £67,000 and the machine weighs 105 tons. It is capable of producing high-speed turbine gears of 90 in. to 216 in. diameter, with a maximum pitch of 1½ D.P.

Diesel-Electric Paddle Tugs. Seven Diesel-electric paddle tugs are to be built for the Admiralty for use in Her Majesty's dockyards. So far, an order for two of these has been placed with YARROW AND CO. LTD., Scotstoun, and two others with WILLIAM SIMONS & CO. LTD., Renfrew. The two to be built at Scotstoun will be laid down very shortly and will be named the Director and the Dexterous. The new tugs will be 145 ft. in length between perpendiculars, with an extreme beam over paddle sponsons of 58 ft., and a moulded depth of 15 ft. Four PAXMAN Diesel generators produce the power for two driving motors coupled to the paddle shafts through RENOLD chain gearing, with a reduction ratio of 8 : 1. The main generators, motors and control gear are being supplied by the BRITISH THOMSON-HOUSTON CO. LTD. Four standard FODEN Diesel generators are being fitted.

Underground Coaches. The Toronto Transit Commission have placed an order for 34 cars for the Toronto Rapid Transit Subway with the GLOUCESTER RAILWAY CARRIAGE AND WAGON CO. LTD., the firm which supplied the 104 original cars for the Subway inaugurated in March, 1954. The 136 traction motors and all batteries and the auxiliary supply equipment for these cars will again be manufactured by CROMPTON PARKINSON LTD., Crompton House, Aldwych, London, W.C.2.

Railway Coaches. An order for railway coaches has been placed by the South African Railways and Harbours Administration with METROPOLITAN-CAMMELL CARRIAGE AND WAGON CO. LTD., Metropolitan-road, Saltley, Birmingham, 8. The contract, which is for 349 coaches for service on electrified lines in the Johannesburg area, is valued at £7,200,000. The electrical traction equipment will be supplied by the METROPOLITAN-VICKERS ELECTRICAL CO. LTD., Trafford Park, Manchester, 17.

International Internal-Combustion Engine Congress (continued from page 750)

OPERATIONAL PROBLEMS OF DIESEL AND OIL ENGINES

FUELS, LUBRICANTS, SCAVENGING AND NOISE

At the morning session on May 25, when the papers in Group B (" General ") were presented, the chair was taken by Professor J. J. Broeze, of the Technical University at Delft.

OIL FUELS FOR RAIL TRACTION

The " General " title given to Group B related rather to the nature of the four papers contained in the group than to the character of the applications described. The first of the four, which was in two parts, was a communication from the World Petroleum Congress dealing with " Some Problems in connection with the Use of Oil Fuels for Railway Traction "; the second, with the relation of cylinder dimensions to the design and performance of Diesel engines for railway and marine service; the third, with impulse scavenging as a means of increasing the power of four-stroke Diesel engines; and the fourth, with " Some Practical Aspects of Engine Noise."

The joint authors of the first of these papers were Mr. R. Brun, head of the research section on motors of the French Railways, who discussed the use of fuels containing a large proportion of catalytic-cracking products, Mr. R. Vichnievsky, assistant director of the Claude Bonnier research station of the French Petroleum Institute, and Mr. R. Courtel, director of the Lubricants Department of the same Institute. Mr. Brun explained that the increasing demand for high-octane petrol necessitated the re-running of the heavy distillates and their catalytic treatment. One of the resulting products was a gas oil with a low cetane number and a high sulphur content, which, for commercial reasons, had to be blended with distillate gas oil. His paper described the combustion characteristics of different mixtures when used in high-speed oil engines (either by straight injection or injection into a pre-combustion chamber as observed in the laboratory), and the results obtained from a supercharged Diesel engine fitted in a shunting locomotive. The laboratory trials showed that the types of engine used by the French Railways operated as well with the cracked gas-oil as with the distillate oil and that they were equally satisfactory from the point of view of maintenance; these results were confirmed in service.

SELECTION OF LUBRICANTS

The second half of the paper, on the selection of lubricants and the maintenance of constant quality, described the test plant at the French Petroleum Institute, where a 5-h.p. Petter single-cylinder engine was used to determine the quality of straight mineral oils and to classify them accordingly. It was found that the method was satisfactory as a guide to their behaviour under service conditions, but, it was added, no laboratory test had yet been devised which would determine the uniformity of quality of an oil containing additives; though, by means of the test engine, it was possible to ascertain that a particular additive oil could be used without risk of failure in service. Mr. Brun stated in replying to the discussion that, over 6,000 hours running, it was found that the consumption of lubricating oil was less when the oil contained additives, because there was less deposit on the piston rings. One of the speakers in the discussion questioned, however, whether results as good could not have been obtained with straight mineral oils. Mr. Brun admitted that the experience of the French Railways pointed in the same direction; in fact, some engines had run up to 8,000 hours on straight mineral lubricants. They were still experimenting with additives and he could say that additives did clean an engine, but whether they affected the rate of wear he was not in a position to state. The number of times that a charge of oil passed through the engine in a given period (which differed with different types of engine) had a marked influence on the cleanliness of the engine.

The next paper, by Professor C. Fayette Taylor, of the Massachusetts Institute of Technology, dealt with " The Relation of Cylinder Size to the Design and Performance of Diesel-Engine Installations for Railway and Marine Service," and was based on experimental work performed on geometrically similar engines constructed for the purpose by M.I.T. For the purpose of the study, " similarity " consisted of having all geometrical proportions the same, and corresponding parts made of the same materials. In a group of similar machines of different sizes, a single member of the group would be identified by its " characteristic length "; in the case of engines, the cylinder bore. Curves were given showing the internal friction of similar engines when driven by an electric motor, the relation of rated brake mean effective pressure and bore, volumetric efficiency and piston speed, piston speed and bore, brake horse-power per square inch of piston area in relation to bore, weight per unit of displacement volume and per brake horse-power related to bore, etc.

In the discussion there was some criticism of the curves, the spots being widely scattered in some instances, and questions were raised regarding the possible connection between combustion efficiency and rate of wear. Professor Taylor replied that while commercial types of engines were not exactly similar, comparisons must be based on the laws of similarity. The available data did not justify a mathematical approach to the subject, and commercial ratings were " not usually reached by rational processes " —in the United States, engine rating was " a hit-or-miss procedure." In his experience, the stroke/bore ratio was the best basis for comparison.

EXHAUST-IMPULSE SCAVENGING

Dr. Ing. René Feiss, of the Swiss Locomotive and Machine Company, Winterthur, was the author of the third paper in Group B, on increasing the power of four-stroke Diesel engines by exhaust-impulse scavenging. By suitable design of the exhaust system of such an engine, he stated, it was possible to increase the power output by 25 per cent. without increasing piston stresses, and a further increase of 20 per cent. could be obtained if a blower were fitted on the suction side of the engine. Examples were cited of marine and rail-traction engines; in the latter case, the advantage was particularly noticeable under conditions of fluctuating load, as in Diesel engines used in shunting locomotives. The discussion on the paper was brief, but generally endorsed the conclusions reached, instances being quoted from French and Italian experience which supported the figures cited in the paper.

The fourth paper in Group B, by Mr. C. H. Bradbury, technical director of Petters, Limited, Staines, Middlesex, on " Some Practical Aspects of Engine Noise," aroused considerable interest. After a general review of the magnitude and type of noise emitted by Diesel engines, the author described his procedure for measuring the noise from particular engines with special reference to the sources of the noise—firing impulses, the fuel-injection system, valve gear, etc.—and discussed the possibility of resonance. Experiments designed to reduce engine noise were also described, by lining the crankcase and doors with absorbent material and by other means. Most of them produced some favourable effect, but, as the author pointed out, in the design of engines, production considerations, efficiency and light weight usually take precedence over the noise aspect in the present state of world markets.

The discussion on this paper ranged over a wide field and contained many divergent views, though there was general agreement that more might be done to insulate noise-making components, for example, by the use of sprayed coatings, and that air intakes were a major source of noise. It was suggested, too, that temperature changes in an engine might affect seriously the sensitivity of microphones, and that, over a period of time, it might be difficult to maintain the fine limits indicated by the author's instrument readings. One speaker considered that the mechanical noise of fuel pumps was not a serious item; but he was immediately followed by another who remarked on the difference in noise level when a dual-fuel engine was changed over from oil to gas, cutting out the fuel pumps. This was confirmed by others. On this point, the author expressed the opinion that fuel pumps should be driven by a separate shaft, so that their noise was not transmitted to the valve gear. He considered that, eventually, it would become customary to provide some measure of sound insulation, especially where Diesel engines were installed in buildings.

To be continued

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ELECTRICITY SUPPLY IN MAY

During May, 1955, 5,209 million kWh were sold by the Central Electricity Authority to the English and Welsh Area Boards. This was an increase of 10·9 per cent. over the figure for May, 1954. When corrected for weather conditions and working days the increase was, however, 9·7 per cent.

The amount of electricity sent out by the Area Boards during the same month was also 5,209 million kWh, of which 129 million kWh were supplied directly by the Central Authority. The increases in the amounts sent out compared with the corresponding figures in May 1954, were 9·9 per cent. in the " mainly industrial " and 11·1 per cent. in the " mainly non-industrial areas."

No account is taken in these figures of supplies received by the Area Boards from other sources. These are, however, comparatively small and have little effect on the percentage changes. " Mainly industrial " areas are those in which industrial consumers took over 50 per cent. of the total sales in the preceding year.

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PLANS FOR NUCLEAR ENGINEERING

We regret that there was an error in the article " Plans for Nuclear Engineering " which appeared on page 716 of our June 10 issue. The paragraph starting at line 24, column 2, should have read: " While these four groups comprise the most important United Kingdom concerns engaged on this work, other companies include Foster Wheeler, Limited, who are associated with Foster Wheeler Corporation, New York. The Corporation have announced that they are able to undertake the design, manufacture and erection of complete nuclear power stations."

Foster Wheeler, Limited, state that while they have made no announcement at all concerning their intentions in this field they are actively engaged in research applicable to the cooling of nuclear power reactors. They have facilities for the design, manufacture and erection of equipment for reactor cooling.

DRAWING AND DESIGN

THE ENGINEER'S FINEST MODE OF EXPRESSION

By H. Clausen, O.B.E., B.SC. (ENG.)

Although results of scientific or experimental work in the form of reports, analyses, papers, diagrams, etc., are quite effective media for the transmission of thought from one man to another they are only a preliminary step in the creation of any new product. Even a detailed specification is only a description of an idea. Drawing is the only medium for the transfer from thought to material in our work. In some activities such as wood carving, jewellery, or model making, an idea can be expressed in material by its creator without passing through the design stage. In practically all engineering work, however, manufacture depends upon detail drawings, covering the shape, size, material, etc., of every component part.

In these drawings the preliminary thought, specifications and calculations, the consideration of alternative designs, research, and experimental work, are processed into a form in which they can be materialised in "hardware." Whether the final product actually embodies the principles it was intended to include depends upon the quality of thought put in at the design stage on the drawing board; and in this stage the realities (as opposed to the potentialities) of the idea are determined. Manufacture presents few difficulties, and is usually quite capable of producing all the qualitities of a good design as expressed in the working drawings. Faulty manufacture is usually the very last cause of failure; the weak spot is almost invariably design—the transition from the thought to the working drawings of the material in which the thought is intended to be embodied.

Although drawing is the only effective medium in which design can be expressed, design is not just drawing, neither is good drawing necessarily good design. The relations between drawing and design are not unlike those between handwriting and poetry or literature. First-class drawing may be—and often is—wasted on a shoddy or inadequate design. A first-class design may be expressed in poor drawings, though this is not usual; a good designer will encourage good drawing.

There are many kinds of drawings, but those referred to here are constructive drawings, as issued for manufacture, with the dimensions, limits, etc., as required shown on them. These drawings determine the quality of the product. Drawings and diagrams of the type usual in patent specifications and handbook illustrations are a different matter altogether. They are descriptive or illustrative drawings. They have some value in manufacture and assembly, but they have no influence on the quality of the product. It is unfortunate that there are no familiar words in which the vast gap between the two kinds of drawings, the illustrative and the constructive, can be readily expressed.

ILLUSTRATIVE AND CONSTRUCTIVE

Oddly enough, men engaged on illustrative drawings, which have no influence on the quality of the product, but merely show how it is meant to work, are often paid more highly than those men on constructive drawings whose work determines the quality and character of the product. The engineer should be able to do both kinds of drawing. His powers will be greatly increased thereby.

The difficulty of seeing, in the working drawings, evidence of the mental effort, research, or creative ability behind them has tended to upset the balance between the "scientific" and the engineering aspects of design. There is no real conflict between these two aspects: each is the necessary complement of the other, and success can only be achieved by the full development of both.

The quality of drawing—as drawing—or draughtsmanship, is measured by the clarity of expression of exactly what is required to be made, without regard to its assembly, testing, and use. It includes such matters as whether the dimensions shown can be readily achieved in manufacture. The quality of design, on the other hand, is measured by the performance of the whole machine of which the items drawn form components. It includes fitness for purpose, ease of manufacture, absence of unnecessary operations, facility of erection, and performance in every meaning of the word. Maintenance and weather protection aspects are included, as well as materials, limits, surface treatment and finish, and other factors. The manufacture of any item is helped by good drawing, just as the pleasure of reading a sonnet is enhanced by its being well spaced and set up in a good fount of type. But good drawing, however good it is, can never turn a bad design into a good one.

Take care of the design and the manufacture will take care of itself. If the design of anything is really well done there is usually little difficulty in getting it made, and almost all defects in performance, and most cases of delay in manufacture, are mainly due to lack of proper attention in the design or drawing-board stage. Neglect in this stage can never be made up by any subsequent activity. It usually means hasty alterations to material already made. This work, usually carried out under difficult conditions and in a hurry, is one of the most expensive and time-wasting activities imaginable (not to mention loss of temper and morale). The only remedy is to go back to the drawing-board stage and do it better.

A common weakness in establishments dealing with design is to pay too much attention to draughtsmanship, and drawing as such, too early in the design stage. First layouts can be very rough, done freehand, using a soft pencil. They should include as many different ways of doing the job as possible. There are usually many ways of approach to a good solution, and the best is not always found first. One should browse over these alternatives, imagining one is trying out a machine built on these lines. Differences in behaviour and in the way that stresses and loads are carried become apparent. This process demands experience as a background, but all design (except for a genius) needs a background of experience as a basis for judgment. Design is an art which must be developed by practice rather than a science which can be taught, or learned by study.

Judgment is one of the most important qualities to cultivate, and next to this, perhaps even more important, is complete sincerity. A man of strong character can force his views on his fellow men so that they almost believe him. It is not possible to force material things to do anything they do not like doing. We often hear some such remark as "This machine must be made to work." With suitable design modifications this may well be possible; but the important thing is that whether it works at all, or well, or badly, is not so much a matter of the machine itself, which must blindly follow the laws of gravity, friction, dynamics, etc., as whether the design is such as to allow it to work. An unsatisfactory design cannot be "made to work"; the design must be such that it cannot help working as intended, and doing so easily.

It is natural that personal preferences or departmental policies should be reflected in design; one may prefer a mechanical, the other an electrical solution. Either may give an equally good solution, but to push a preference beyond the limits of impartial judgment and complete sincerity is fatal. This may seem to demand too much from human nature, but no design is better than its designer; a sound basis of simple ethics is the best foundation for research and design. This is merely another way of describing the attitude of mind reflected in the phrase "the scientific approach." The same idea is expressed in St. Paul's saying:—"Prove all things: hold fast that which is good." What better advice could be given to any engineer or designer?

In any formal organisation, particularly a Service one, there is usually a tradition of obedience to authority, and a belief in the wisdom of one's superiors. In design work, on the other hand, one of the first lessons to be learned is that you should not believe a word of what anybody tells you, no matter who he is, unless you are personally satisfied that it is so. If you are not satisfied, keep an open mind. It may be so, or may not; but sure enough, if you believe it, and act on that belief without fully understanding it, you will be let down, not by anyone else but by yourself.

ROUGH DRAFTS

A common weakness in many (though not all) departments and industrial establishments is the relation between engineers or scientists, and draughtsmen. The engineer is usually responsible for design, but the execution is often left entirely to draughtsmen, the engineer or scientist criticising the result but not giving much of a lead as to how the thing should be done. In all too many cases we have the "sketch on the back of an envelope" given to the draughtsman to knock into shape, so that the originator can criticise it. This does not seem good leadership to me. If the engineer cannot make his own rough draft, with enough detail for preliminary consideration, he is no leader. Leadershp involves not so much telling people what to do, as showing them, by precept and example, how to do it. New ideas usually involve consideration of many alternatives, and the engineer or scientist should be able to do some of these first outlines himself much better and quicker than any of his draughtsmen.

It is hard enough to express one's own ideas clearly; it is beyond reason to expect others to express them for you. Professor M'Ewen in a recent address commented on the better training that architectural students received compared with engineers, in that in the former case much more attention was given to drawing. It was well said. The engineer who cannot draw is in much the same state as would be a man engaged in clerical work who could neither read nor write.

It has been said that the engineer or scientist cannot afford to waste his time and talents on a drawing board. This is nonsense. The engineer must be a master of the only medium of expression; and unless he can draw he will not be able to give proper consideration and guidance to other men's drawings. In many cases some faintly squared paper and a soft pencil (and a large piece of indiarubber) are all that is needed. Not only should sketching and drawing be practised and used regularly as a working tool by all engineers; neat figuring and lettering show that thought has been given to the sole purpose of the drawing or diagram, namely, that someone else should be able to read it easily. It is worth hours of spare time practising a plain formal lettering and script. I believe no Continental engineer would sit for his examinations until he had mastered this simple and useful art.

A properly organised drawing office is the place where creative ability and talent are best recognised and developed. Its success in this respect is a measure of the quality of the organisation of which it forms a part. It should be regarded as an essential recruiting and training ground for designers and engineers. All too often, however, we find it forms a backwater, detached from the main stream, with very small prospects of promotion in it. In some way or other the idea has grown up that "working on the board" is below the dignity of an engineer or scientist, in contrast to the more sensible attitude of the architect.

The sooner this idea is dropped the better. How else does the engineer expect to express his

ideas? Read the obituary notices in the technical journals of eminent engineers: in almost every case we find that the subject, after completing his apprenticeship with Messrs. Blank & Co., worked in the drawing office of Messrs. Dash, and this led to . . . . . A recent biography of Sir Frank Whittle states that he had spent most of his working life on the drawing board. There is nothing surprising in this; where else could the creation of the jet engine—or any other engineering achievement—have been done?

IMPORTANCE OF DETAIL

It is often said that senior men should not concern themselves with detail, this being left to juniors. This is a serious fallacy. The whole design is only an arrangement of details. Once a real design is in hand the general principles have usually been accepted long ago, and can be taken for granted. The detail is the matter of supreme importance; the whole thing, in fact. An error of judgment in respect of one single detail may, and often does, make all the difference between success and failure. No detail is too insignificant for the leader's attention. When many thousand details are involved in one job this looks formidable, but he should look at every single one. One can size up in a few seconds whether attention is needed or not, and give it further thought, without losing track of the overall design. Mechanical engineering detail is usually of great importance; alterations after trial are difficult to make. This is not to say that the chief designer or project leader should check every dimension. But there has been a tendency in recent years to neglect meticulous checking, with disastrous results in wasted time in the shops. The time of the most experienced man in the drawing office is well spent in checking the work of others, combining this, naturally enough, with advice and guidance to juniors.

The philosophy of engineering design as outlined above applies equally well to, say, the circuit diagram of a radar system, and its subsequent development. This circuit diagram work is a wizardry of its own, and everything depends on it; but it only defines the potentialities, not the realities of performance. It may be a complete medium of expression from one radar expert to another, but not to the man (or men) who is to make it, and it does not define the actual performance in any way. The diagram is symbolised thought, like a mathematical expression: it needs interpreting in working drawings before it can be made in other than a " bread board " form, and this interpretation needs an ability of the same order as the formulation, though different in kind.

This brings up a very important matter—the bread-board or demonstration model, which seems to be a necessity in the design stage of radar gear, where the idea must be tried out before real design, or so called " engineering " can be started. In other directions, however, the bread-board model may be a danger. One occasionally sees trial models rigged up " to illustrate a principle," without much regard to a proper manufacturing design. A model of this type may work quite well, up to a point, by virtue of its defects. A recast of the design and more accurate manufacture may result in the thing refusing to work at all.

Small models of cardboard, or Meccano, can be of very great value, and may be essential in the development of ideas, or complete scale models may be needed for structural tests; but here again, only the potentialities of the idea and not all of them, are covered. The realities lie in the design as expressed, not in fancy pictures, but in the working drawings.

I end with a quotation from Dr. Ing. J. Roemmelt, one of the senior design engineers of Krupps. He writes in English, and I only wish that my German was as good as his English. At the end of his " Practical Hints on the Design of Naval Gun Mountings," he says:—

" Moreover the designs cannot all be treated in an abstract way, but often can only be made with feeling, experience, and estimation. A good designer therefore must be possessed of a high degree of technical sensitiveness and creative spirit. The leader of a designing department must act as a clear-sighted pioneer, and on no account must he leave the work to subordinate collaborators. Thus the work of the leading engineer must take up the whole of his activity, and not only provide him with the means necessary for his livelihood, since otherwise the creative spirit is lost.

Moreover the superior must draw the attention of his collaborators to the fineness and beauty of work and awaken their interest even in simple tasks, which by the way sometimes cause more efforts than many a part which appears important at first sight.

Anyhow all persons engaged in such an intensive work must devote themselves to their task with real ardour, and according to the poet's saying they must feel in their very bones what they create with consideration and good judgment.

It is only in this way that a good efficiency can be obtained."

ELECTRIFYING THE UNDERGROUND

JUBILEE OF CONVERSION ON THE METROPOLITAN AND DISTRICT RAILWAYS

The present London Underground system of lines consists of two types of railway which originated separately, the old steam-worked routes and the tube lines; the latter, which made their appearance over a quarter of a century later, were operated electrically from the beginning. The first section of the former was opened on January 10, 1863, and ran between Paddington and Farringdon Street; it was worked for a time on the broad gauge by Great Western trains. A dispute over the terms of working, however, led to the Metropolitan Railway Company having to work the traffic itself on the standard gauge, and for this purpose a powerful 4-4-0 type outside-cylinder condensing tank locomotive was built to the requirements of Sir John Fowler, by Beyer, Peacock and Company, Limited, of Manchester. A later one of the type is shown below.

In 1863 a Select Committee of the House of Lords considered it desirable to complete " an inner circuit of railway which should abut upon, if it did not actually join, nearly all the principal railway termini in the Metropolis . . . " and the construction of the " Inner Circle " was the direct outcome of this recommendation. East of Kensington this route, not fully completed until 1884, was formed by the lines owned by the Metropolitan District Railway Company, at first worked by the Metropolitan Railway Company, but using its own locomotives (also of the 4-4-0 type and obtained from Beyer, Peacocks) and rolling stock from 1871 onwards, in which year the line reached the Mansion House in the City. Both railways were extended above ground into the suburbs, Ealing being reached in 1879 and Harrow in 1880, while connections with the main line railways, some of which sent their trains (including some goods trains) through the underground lines, gave a very complete system of communication on which traffic grew to a remarkable extent. The Metropolitan and District lines alone carried 114,450,000 passengers in 1884, and in 1894 the figure had risen to 130,611,000. Their history reflects not only the growth of London and the changes that have taken place in the lives and habits of its people, but also those that have come about in transport facilities and which have so closely affected those habits. The extensions brought development in their wake and played no small part in the dispersal of population which has been to the general betterment of Londoners. An example of a station of the pre-electric period is shown in the illustration of South Kensington station on page 787, taken at some time during the Boer War.

Some time before the completion of the " Inner Circle," the District Railway, the first section of which was opened in 1868, had assumed the character of a separate system connecting the western and south-western suburbs with the West End and the City. It became an important suburban artery and provided what was for those days a convenient route across London from west to east. The Metropolitan lines afforded a like facility in other directions. By using from the outset efficient signalling arrangements and a good system of block working, later converted into lock-and-block, both railways were able to provide a very frequent service, in spite of the difficulties inseparable from tunnel working, with great freedom from accident. By the year 1905, when the change to electric operation on tunnel sections began with the introduction of electric trains over the St. John's Wood line of the Metropolitan on January 1, only one passenger had lost his life in a " train " accident. This occurred near Earls Court on January 29, 1876.

TUBE COMPETITION

On December 18, 1890, the first electric tube railway, the City and South London, was opened between the City and Stockwell.

Until 1905 trains on the District Railway were hauled by 4-4-0 condensing tank locomotives. No. 33 was built in 1881 and eventually scrapped in 1925.

Although suffering from the disadvantage of having rather small tunnels (it had been planned as a kind of underground cable tramway) it proved most successful, and was followed in 1898, by a short line connecting Waterloo with the City. In July, 1900, the Central London Railway—speedily nicknamed the "twopenny tube"—was opened between Shepherds Bush and the Bank. Its equipment was in every way far in advance of that of its predecessors and it subjected the older steam lines to severe competition, the Inner Circle, and Hammersmith and City routes being particularly affected. The advent of the electric tram and mechanically propelled omnibus also underlined the urgent need to modernise those lines. From May, 1900, the two companies interested in the Inner Circle had run an experimental compartment-type electric train between High Street, Kensington, and Earls Court, using the 3rd and 4th rail system, with a conductor rail on each side of the track, an arrangement later used on the Great Northern and City Railway. At first a special fare of one shilling was charged and the novelty attracted some custom for a time; this eventually fell off, although ordinary fares were introduced, and the train ceased running in the November.

In the following year it was decided to electrify the District lines and the Metropolitan District Electric Traction Company, Limited, was formed to carry out the work. This was absorbed a few months later into the Underground Electric Railways Company of London, Limited, which also entered into agreements to build and equip the three tube railways later known as the Piccadilly, Bakerloo and Hampstead lines. This involved the construction of the great electric generating station at Lots-road, Chelsea. American interests were prominent in this work and proposed to adopt the low-voltage direct-current system of traction, with positive conductor rail outside the track and negative in the centre, a scheme which was also adopted for the conversion of the Mersey Railway, completed in 1903. The Metropolitan Company, however, which also had decided to abandon steam, wished to use the high-voltage three-phase alternating-current system, in use on a few Continental lines. Arbitration was resorted to, and a tribunal of the Board of Trade decided in favour of the direct-current system. The Metropolitan Company decided to erect its own generating station at Neasden.

The District Company's Ealing and Harrow line had been finished some time before but had never been opened with steam traction. It was converted to electric working and the service began in June, 1903, the conductor rails being taken through from the junction at Hanger Lane to Mill Hill Park (now Acton Town) over the older route opened in 1879. In June, 1905, with the opening of South Acton station, an electric service was begun between that point and Hounslow, the rest of the services being as yet steam worked. It had been realised that it would be impossible to obtain all the benefits offered by electrification unless some better method of signalling were introduced, but to do that meant producing an automatic system which could be expected to receive the approval of the Board of Trade, then the governing authority in such matters. Track-circuit automatic signalling had for some time been successfully applied on many American railways, and in 1902 was adopted by the London and South Western and shortly after by the North Eastern Railway. To apply it to electrically-worked railways, however, was much more difficult, owing to risk of irregular action by extraneous current, but the Boston Elevated Railway had been opened in June, 1901, with a system designed to overcome that and which gave satisfaction after certain improvements had been effected.

ILLUMINATED TRACK DIAGRAM

It was accordingly resolved to fit similar equipment on the Ealing and Harrow Railway, and in due course this received the approval of the Board of Trade. The semaphore signals were actuated by compressed air, electrically controlled, and orders were placed for the equipment needed to replace the old signalling on the District line and equip the three tube railways above mentioned. At most junctions and stations where there were sidings, etc., electro-pneumatic power interlocking frames were installed. The signal box at Mill Hill Park, brought into use in June, 1905, contained the first known illuminated track diagram on which the positions of the trains were shown by extinguishing lamps (normally burning) behind the track circuit sections concerned. With this equipment a considerable shortening of the block sections became possible and signal boxes were required only at a few selected places. Trains were announced from one box to another by a storage-type train description apparatus which operated illuminated indicators on the station platforms showing the destinations of the next three approaching trains. Automatic train-stop mechanisms applied the brakes if a motorman passed a signal at danger. The signals in the tunnels consisted of spectacle mechanisms, moving coloured glasses by means of air cylinders; points were operated on the same principle.

On July 1, 1905, a cross-London electric service was introduced between Ealing and Whitechapel, and the abandonment of steam on the remaining sections quickly followed. The Inner Circle service, run in conjunction with the Metropolitan Company, was entirely electric by the end of September, and on November 5 the last District steam train was withdrawn. The change brought a new lease of life to the District. In steam days the approximate number of trains daily was 884; the electric service at first called for 1,044 but was gradually augmented until by 1928 the number was no fewer than 2,168. The 3½-min. average interval between trains on the Mansion House to South Kensington section was cut to 2½ minutes in 1907 and to 90 seconds in 1928. To-day the District line is the busiest of all London Transport tracks in peak periods, providing a 90-second headway for a longer period during the peak hours than any other line. Passengers carried annually have increased from between 40 and 50 million in the last steam years to 55 million in the first full year of electric working and to 147 million in 1920. Improvement in all items of equipment and rolling stock has been continuous, and the District service is to-day mainly provided by the latest type of surface-line stock, with a large proportion of lightweight aluminium-alloy bodies.

Arched roofs were common to most of the stations, as shown in this illustration of South Kensington taken some time during the Boer War. Some of this type still survive.

* * *

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in ENGINEERING.

Atomic Energy Research at Harwell. By K. E. B. JAY. Published for the United Kingdom Atomic Energy Authority by *Butterworths Scientific Publications*, 88 *Kingsway, London, W.C.*2. (5*s.*)

The purpose of this report is to continue the story of the Atomic Energy Research Establishment from the point at which it was left in the report of 1952 (*Harwell—the British Atomic Energy Research Establishment*, 1946–1951) up to the formation of the United Kingdom Atomic Energy Authority in August, 1954. In addition, changes in the international agreements concerning the release of information hitherto treated as secret have made it possible to discuss certain subjects in more detail than in the previous report. Part I deals with the major programmes of the Establishment and is written primarily for the non-technical reader. Part II covers selected researches in more detail and is written for scientific readers who have not specialised in the various fields discussed.

Mix Design and Quality Control of Concrete. Proceedings of a Symposium organised by the Cement and Concrete Association in conjunction with the Prestressed Concrete Development Group, the Reinforced Concrete Association, and the Research Committee for the Cast Stone and Cast Concrete Products Industry. *Cement and Concrete Association*, 52 *Grosvenor-gardens, London, S.W.*1. (45*s.*)

The present volume represents the written record of a symposium which was attended by 1,500 engineers. That so many should have found the time to attend a three-day conference on such a relatively limited subject is a clear indication of the importance concrete has assumed as a structural medium, as well as being an acknowledgment of the success achieved by the organisers. Twenty-two papers—with the ensuing discussions—are presented in the volume, which thereby forms an excellent reference book on the design and quality control of concrete in modern civil-engineering practice, giving an account of the work that has been done and indicating the problems yet to be solved.

Agricultural Process Engineering. By S. M. HENDERSON and R. L. PERRY. *John Wiley and Sons, Incorporated*, 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (8·50 dols.); and *Chapman and Hall, Limited*, 37 *Essex-street, London, W.C.*2. (68*s.*)

The engineering theory and practice of processing agricultural products are described in this book. There is a certain amount of introductory theory, followed by sections on pumps, fans, size reduction, cleaning and sorting, materials handling, drying, refrigeration, records, cost analysis and plant design. The book has been written for the advanced student of agricultural engineering, and demands a good knowledge of mathematics and thermodynamics.

A Bibliography of Colour Television: Supplement, 1955. *The Television Society*, 164 *Shaftesbury-avenue, London, W.C.*2. (1*s.* 6*d.*)

This supplement is issued to bring the original bibliography up to date, and includes references from January, 1954, to January, 1955, as well as some additional references omitted from the original edition. Copies of the original bibliography, which was mentioned in Weekly Survey in the issue of June 25, 1954, page 802, may still be obtained from the above address.

BOOK REVIEWS

Protective Current Transformers and Circuits. By P. MATHEWS. *Chapman and Hall, Limited*, 37 *Essex-street, London, W.C.*2. (36*s.*)

This book is the latest addition to a series of "Advanced Engineering Text-books" now appearing, with the commendation of the British Thomson-Houston Company, as authoritative reviews of specialised fields of electrical technology. It deals with a subject of considerable complexity and is addressed to the professional designer and to the better-informed protective-gear user and consultant rather than to the non-specialised engineer and student. The mood is earnest; there are no historical or prophetic digressions and there is a stark exclusion of all but the most inevitable references to protective systems as a whole. Within the strict scope of its title it provides a very thorough account of the principles underlying a difficult and poorly-documented subject. The book is in two main parts, dealing with steady state and transient effects respectively, and there is a chapter on general design considerations and testing sandwiched rather uncomfortably between them. Throughout the work the author makes free use of mathematical methods and shows an unusual turn of skill in the manipulation of algebra without, however, overtaxing the resources of a reasonably equipped reader.

Part I starts from first principles and from the idea of linear (iron-less) transformers, passing to the examination of the behaviour of single-current transformers having ferro-magnetic cores and with various secondary reactances and typical burdens. Groups of current transformers, applied in what the author likes to call "zonal protection," are next considered, and this is followed by a chapter on special applications including as examples mixed over-current and earth-fault systems, core-balance protection, and the use of self-stabilising transformers for the overall protection of power transformers with ratio adjustment.

The more important Part II covers much the same ground, but this time from the viewpoint of transient effects, careful distinction being made between the characteristics of primary currents of the type produced by power-system short circuits, and those due to the magnetising transients occurring on switching transformers. The theoretical treatment of ferro-magnetic effects in current transformers is based on the assumption of constant core permeability up to a limiting knee-point at which saturation occurs abruptly and thereafter remains complete. This type of assumption makes for reasonably practicable analysis and is normally adopted with satisfactory results in computing the performance of transductors with which, in fact, saturable current transformers have many characteristics in common. The problems studied are naturally of a different order from those in Part I, and are mainly concerned with devices designed to reduce the influence of core saturation in causing departures from proportionality between secondary and primary quantities, and in producing instability in systems employing summation. Examples of series- and shunt-stabilising elements associated with the fault detection relay are considered, as well as more complicated arrangements where, in the author's view, these can be justified. Practical aspects of the subject receive reasonably adequate treatment and there are many worked examples based upon good contemporary usage. Operators will be particularly interested in the description and photographs of a testing equipment used for proving complete equipments. This is virtually a small scale version of the kind of plant employed for the short-circuit testing of switchgear, and provides vivid demonstration of the growth of importance of testing technique in recent days.

The author is a well-known practitioner in his special field, and has naturally given pride of place to the devices and practices with which he and his Company have been associated. To the experienced reader, however, this is no drawback as the underlying principles form a common basis for all studies of this nature. The book follows closely after the publication of B.S. 2046 but covers a much wider scope than that Standard. When the B.S.I. comes to extend its activities to cover the more advanced types of protective equipment it will doubtless have regard to much that is set forth in this book. It is to be hoped, therefore, that many of the somewhat quaint expressions used by the author will be replaced in future editions by more normal ones. This would have the incidental benefit of at least partially eliminating the glossary which is now necessary for full understanding of the private language of the protective-gear specialist.

The Bomb, Survival and You: Protection for People, Buildings, Equipment. By FRED N. SEVERUD and ANTHONY F. MERRILL. *Reinhold Publishing Corporation*, 430 *Park-avenue, New York* 22, *N.Y., U.S.A.* (6 dols.); and *Chapman and Hall, Limited*, 37 *Essex-street, London, W.C.*2. (48*s.*)

In a recent leading article in *The Times* it was reported that the advice given to Americans for civil defence was to "Dig, die or get out." *The Bomb, Survival and You*, written by two Americans, offers little advice on any of these topics. It devotes practically the whole of its contents to the supposition that it is desirable and possible to do something about existing buildings and to take precautions in new buildings to render them less liable to damage from nuclear weapons. It is a plea to architects, and through them to their clients, to do something rather than sit back apathetically saying nothing can be done. As the authors rightly point out, there is a lot that can be done, provided the need is realised and that it is not a "glass-house" that is being required. It is a curious commentary on life that, with the advent of the atomic era, modern buildings appear to have less and less protection in their curtain walling and that glass, the worst hazard of all in an attack, is used in large quantities.

Written by men who professedly have no inside knowledge, the book is a surprisingly critical appraisal not only of the technical but also of the psychological and political problems which confront both individuals and governments when considering their attitude to what, if anything, should be done to minimise the effects of nuclear weapons.

Certain governments of smaller nations have enacted laws which provide for new buildings to have shelter accommodation, and others that over a certain number of storeys the buildings should be framed. Sweden has actually gone as far as constructing large shelters in the rock for both civilian shelter and for certain factories, yet governments of larger countries have hesitated to take any such steps, no doubt influenced by the alarming cost both in manpower and materials which it would entail. Nevertheless, presuming that we have to continue to live under the threat of such an attack, it is a problem which should be faced, if not by governments, then by owners of buildings.

The *raison d'etre* for this book at this point in time would appear to be the declassification of the American reports on the damage at Nagasaki and Hiroshima. These the authors attempt to review and from their review offer advice on structural precautions which can be taken to reduce damage. It claims to publish for the first time photographs of the damage in these cities, though certain of them were published by the Stationery Office in the report of the British Mission to Japan and others in *Effects of Atomic Weapons*, published by the United States Government. The authors make only one reference to this book, which is surprising since it too is partly an analysis of the same damage and is also the only authoritative text book published on the physical and radiological effects of the bomb written by those intimately connected with the subject.

One of the structural problems discussed at some length is whether it is better to construct a building with or without large window openings, and the analogous problem of whether it is better to use a light or heavy sheeting for industrial buildings. A building with numerous vents does not receive as a whole as great a force from atomic blast as one with few or no windows, since the blast diffracts through the openings and equalises itself on the panels very quickly; similarly the framework of a shed building with a light covering will be less damaged than one with a heavy covering, because the sheeting blows away before transferring all the blast force to the frame. The authors opt for the windows and the light sheeting on the grounds that there will be something to repair rather than complete structural collapse. One wonders, however, whether if they had walked the ruins of Nagasaki and Hiroshima with the structurally intact yet burnt out interiors they would have been of the same mind; or if they had considered the supply position for replacing coverings after even one bomb, they might not have thought again. In the latter case, particularly, they might have changed their minds, since it is the natural elements, not nuclear weapons, which are real enemies of machine tools.

The book rightly regrets what it calls the missing link-test data. From all the American tests little or nothing has been disclosed, so that it is impossible to know whether structures in any quantity or variety have been tested to determine their behaviour. It would seem to be as desirable to know what atomic blast can do as to know the characteristics of the blast wave itself, even if interest lies mainly in the offensive as opposed to the defensive aspect of the weapon.

The design loads recommended by the authors for designing new buildings are open to question, as is their formulae for the assessment of pressure at a given distance, but at least they have the courage to put some figure down. It is probably desirable to design buildings, or at least shelter accommodation in a building, for some higher load than that specified for normal conditions.

In this book are to be found many suggestions for strengthening existing structures and designing new ones. Some are fanciful and of doubtful value, but others have their good points and could be developed further.

In a review of this length it is impossible to deal in any detail with all the suggestions made; perhaps it is not necessary, since it is felt that the real worth of the book is not so much in the suggestions themselves as in fulfilling the authors' aim—"we regard it as only the initial word and hope it will serve to stimulate more definite efforts on the part of others." It does discuss the problem of structural defence in a sensible and realistic way without belittling or exaggerating the difficulties. Some of their conclusions obtained from their examination and assessment of the damage when applied to design problems should be treated with reserve, but taken as a whole this book should stimulate architects and engineers to consider what should be done about building in an atomic age.

* * *

BUILDING RESEARCH

Open Days at Watford Laboratories

With the object of making the results of recent researches undertaken at the Building Research Station, Watford, more extensively known and used, the laboratories devoted to the civil and structural engineering work of the Station will be open to visitors from 10 a.m. to 1 p.m. and from 2 p.m. to 5 p.m. on Monday and Tuesday, July 18 and 19.

It is expected that full-scale or nearly full-scale tests on normal reinforced-concrete and pre-stressed-concrete members, a brick masonry pier, a single-panel steel frame, and composite floor systems will be in progress, in addition to tests employing small-scale models, and tests of concrete and soil specimens. Some experimental techniques used in the field in tests on existing structures, foundations, dams and flood banks, and in the measurement of earth pressures, will also be illustrated.

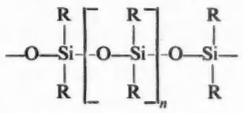
SILICONES AS ENGINEERING MATERIALS

ELECTRICAL, MECHANICAL AND CHEMICAL APPLICATIONS

By L. P. Smith, PH.D., D.I.C.

Although silicone polymers were introduced on a commercial scale in Great Britain in 1945 there are few engineers who are aware of the extent to which their exceptional properties can be utilised in practice. In fact, the question " What is a silicone ? " is still frequently asked.

Physically, the silicones can be water-white fluids, resins, elastomers or a variety of grease-like compounds. Chemically, they are a group of materials based on the organopolysiloxanes which have the general formula,

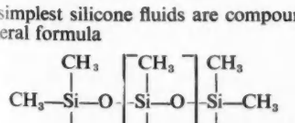


where *n* can vary from O to many thousands and R can represent a large variety of radicals ranging from hydroxyls to other polysiloxanes. The radicals on one polymer need not be the same and an almost infinite number of variations is theoretically possible. In practice, however, R is usually a simple alkyl or aryl radical and the variation of radicals within a molecule is limited. In spite of these variations in composition and form, certain properties are common to all silicones; the most important being outstanding resistance to extremes of temperature and to oxidation combined with excellent electrical characteristics.

The study of the chemistry of organo-silicon compounds started with the preparation of silicon tetrachloride by Berzelius in 1823. It was, however, the application of the Grignard synthesis by Kipping in 1904 that allowed a systematic study of these compounds to be made. Kipping's experiments were often confused by the formation of viscous fluids and resins but although he did not recognise its potentialities he identified the presence of the silicon-oxygen linkage as early as 1914. In 1932 the Corning Glass Works and the General Electric Company in the United States undertook further research on silicon-oxygen polymers as part of their search for electrical insulating materials that could be used at high temperatures. The results of these studies and increased knowledge of the properties and methods of manufacture of high molecular-weight polymers obtained by Carother's work on polyamides led to the introduction of the first commercial silicone in 1942. This was a dielectric compound for use on the ignition systems of high-flying aircraft and is still in use for this and many other purposes. Fluids, resins and elastomers were rapidly developed, and in America alone the production of silicones increased at the rate of about 40 per cent. per year in the first ten years. The average growth of chemical industry in the same period was about 9 per cent. per year.[1]

SILICONE FLUIDS

The simplest silicone fluids are compounds of the general formula



where *n* can vary from O, to over 2,000. These compounds are water-white fluids having viscosities centistokes from 0·65 to over 1,000,000 at 25 deg. C. The most useful property of the polydimethylsiloxanes is their exceptional stability when compared with organic fluids. It is inherent in their chemical structure and may be observed in many of their properties. For example, a useful illustration is obtained by comparing the change in viscosity with temperature of a high quality SAE 30 motor oil and a silicone fluid of comparable viscosity (i.e. 350 centistokes) at room temperature. On cooling, the viscosity of the SAE 30 oil increases from 6·6 centistokes at 120 deg. C to 70,000 at − 25 deg. C., whereas the silicone fluid increases only from 75 to 1,300 centistokes over the same temperature range. This represents an increase of only 17 times as compared with about 1,000 times for the petroleum oil.

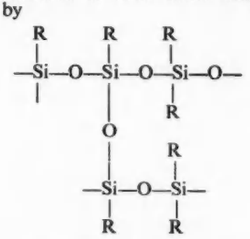
The practical working range for the dimethyl fluids will depend on the viscosity used but will usually be between − 40 deg. C. and 200 deg. C. Other useful properties of the dimethyl fluids are their low volatility, low surface tension, resistance to breakdown under shear forces, resistance to oxidation, water repellency and good dielectric properties.

Better oxidation stability, better lubricating properties and in some cases lower freezing points may be obtained if some of the methyl groups in the formula given above are replaced by phenyls. The extent of the substitution will depend upon the properties required but Fig. 1 illustrates the effect that the addition of small percentages of phenyl groups has on the freezing point of a dimethyl fluid.

Another variation of the silicone fluids is that in which some of the methyl groups are replaced with hydrogen. These materials are generally low-viscosity liquids having a light straw colour. The presence of the hydrogen atoms enables a certain amount of cross-linking to take place if the material is heated under oxidising conditions to about 150 deg. C. and forms a method of applying a silicone resin to surfaces that cannot be subjected to high temperature. An example of this is in the treatment of textiles to render them water repellent.

STRUCTURE OF SILICONE RESINS

The silicone resins, as would be expected, have a higher degree of cross linking than the fluids and therefore have a lower R/Si ratio. The general structure of these resins may be represented by



Pure alkyl resins tend to be oily liquids or weak gels unless the R/Si ratio is below 1·5. Similarly, pure aryl resins are brittle, vitreous solids which are too weak to use by themselves. Mixtures of alkyl and aryl groups, however, produce resins which have a good balance of flexibility, strength and infusibility (in the cured condition). For example, a typical methyl-phenyl resin would be one having 1·00 methyl group and 0·8 phenyl group per silicon atom, the higher proportion of methyl group usually being preferred in order to avoid brittleness.

During their production the cross linking of the resins can be arrested by the addition of organic solvents such as xylene and usually the resins are supplied as 50-70 per cent. solids in one of these solvents. When they are used the solvent is allowed to evaporate and the resin is polymerised by heat treatment and in some cases by the addition of organo-metallic catalysts, such as lead octoate. Further heat treatment is carried out in ovens which have a forced-air circulation in order to remove the polymerisation products and to provide plenty of oxygen for the polymerisation itself. In general, silicone resins are thermosetting and after polymerisation are stable at temperatures up to 250 deg. C.

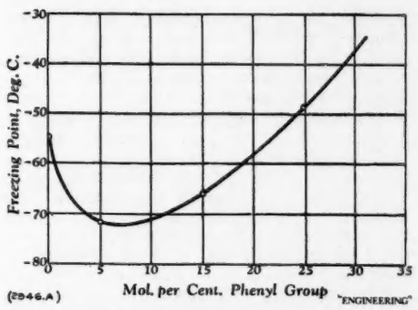


Fig. 1 Substitution of phenyl groups for methyl groups in silicone fluids first produces a depression of the freezing point, but when the amount added is appreciable the freezing point rises.

Very little information is published about the chemical structure of commercial resins and it is usual to classify them according to their application, as follows: coating resins (e.g., paint resins); laminating resins; water-repellent resins (for use on concrete and masonry); moulding resins; electrical resins; resins used as release agents (e.g., the coating of bread tins to prevent sticking). This classification is not entirely satisfactory because some resins can be used for more than one application; however, the advantages obtained are similar in each case and can be summarised as: heat stability (− 50 deg. to + 200 deg. C.); water repellency; good dielectric properties; resistance to many chemicals; weather resistance.

One disadvantage of silicone resins, especially in the protective-coating field, is the high temperatures required for polymerisation. This difficulty can be overcome at some sacrifice in heat resistance by a combination of a silicone resin and an organic resin, usually an alkyd. Silicone and alkyd resins can be cold mixed but the compatibility of the silicone resins is limited and this method is restricted in its application. More satisfactory results are obtained with the silicone-modified alkyds where a chemical combination exists. The copolymer can be incorporated in an air drying paint which will have a maximum useful temperature of 200 deg. C. as compared with 150 deg. C. for the organic and 250 deg. C. for the silicone materials used alone.

COMPOUNDING WITH FILLERS TO FORM RUBBERS

Silicone fluids having molecular weights of approximately 500,000 and viscosities between ten and twelve million centistokes can be used to prepare silicone rubbers. The fluids are so viscous that they flow only very slowly at room temperature, but they still behave as Newtonian liquids. When the chains are cross-linked at appropriate intervals, however, an elastic material is obtained. The silicone gel or gum is weak and it is necessary to compound it with inorganic heat-stable reinforcing fillers such as silica, titania, alumina, zinc oxide or iron oxides. The process of crosslinking or vulcanisation differs from that of organic rubber since the unvulcanised silicone polymer is fully saturated. Therefore, before crosslinking can take place, the side groups must be attacked and the vulcanising agent must be a powerful oxidising material, such as benzoyl peroxide or tertiary butyl

perbenzoate. A typical silicone-rubber formulation would then be:

Silicone rubber gum	100 parts
Finely divided silica	40 parts
Benzoyl peroxide	2 parts

When these ingredients are mixed, usually on a differential two-roll mill, a stock is obtained that can be moulded, calendered, extruded, etc., on normal organic-rubber processing plant. The vulcanising conditions, however, are more exacting than those required for natural rubber and a final cure in a forced-air-circulation oven for 24 hours at 250 deg. C. is required for the optimum properties to be obtained.

The wide range of properties that can be obtained by altering the base polymer and the type and quantity of the fillers is shown in Table I. However, there is no universal formula-

TABLE I.—*Range of Properties of Silicone Rubbers*

Specific gravity	1·1 to 2·2
Hardness B.S. degrees	35 to 90
Tension strength, lb. per sq. in.	400 to 900
Ultimate elongation, per cent.	60 to 500
Compression set* at 150 deg. C., per cent.	Most grades 50 to 80 Special grades 10 to 30
Brittle point, maximum	All grades − 57 deg. C. Special grades − 79 deg. C.
Dielectric strength, V/mm.	Up to 32,000
Dielectric constant at 10^3 c/s	As low as 2·9
10^6 c/s	
Power factor at 10^3 c/s	As low as 0·0015
10^6 c/s	
Thermal conductivity, cal. per cm. per deg. C. per sec.	$0{\cdot}4 - 0{\cdot}67 \times 10^{-3}$
Specific heat, cal. per gm. per deg. C.	About 0·3
Tear strength, lb. per in.	50-100
Abrasion resistance (Dupont), c.c. per hr.	0·6-16·0

* Expressed as a percentage of the compression given.

tion that will meet all requirements and the most suitable elastomer for a given purpose usually provides a compromise between the desired properties.

At room temperature the silicone rubbers are not as strong as organic rubbers but they will retain up to 80 per cent. of their strength over the temperature range − 60 deg. C. to 250 deg. C., at which temperatures other rubbers would be useless. In addition, the resistance of silicone rubbers to atmospheric oxidation is extremely good and this property may make their use advantageous even at room temperature.

It will be noted that in Table I reference is made to special grades of silicone rubber which have low compression set and extremely low temperature properties. The first property may be obtained by the addition of 0·5 to 2 parts of cadmium oxide or mercuric oxide, and the second by using a gum based on a methyl-phenyl fluid (c.f. methyl-phenyl fluids above).

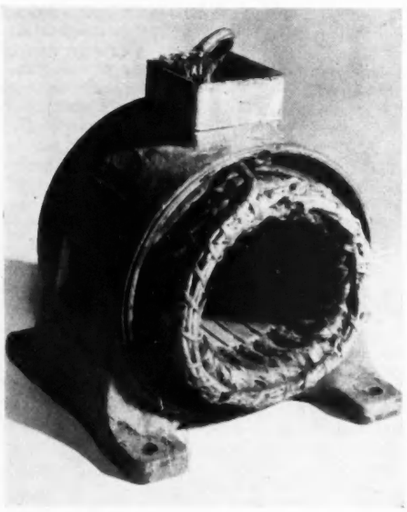


Fig. 2 A silicone-insulated stator after 4½ years pump duty on a thioglycollic-acid plant. Under the grime the insulation showed no signs of ageing, although class-A insulation previously used had only lasted from 3 to 6 months.

A new type of silicone rubber gum has recently been introduced which can be mixed with organic rubbers and which can be polymerised by sulphur. The long oven cures required by pure silicone rubber can also be eliminated. Little data has been published on the properties obtained by silicone-organic mixtures but it is claimed that the oxidation and temperature resistance of organic rubber can be greatly improved by the addition of about 10 per cent. of the silicone gum.

SILICONE MOULDING POWDER

By adding suitable inert and heat-stable materials to the silicones or by combining the silicones with suitable organic groups, a wide variety of useful materials can be obtained. For example, glass fibre, asbestos, or diatomaceous earth may be mixed with a silicone resin to produce a silicone moulding powder; the addition of finely divided silica to a silicone fluid produces a grease-like compound that retains a consistency similar to that of white petroleum jelly over a temperature range of − 50 deg. C. to + 200 deg. C.

Silicone lubricating greases can be prepared by the addition of metallic soaps or finely divided carbon black to a suitable silicone fluid. The greases are non-corrosive, water repellent and retain their consistency over the temperature range − 73 deg. C. to 200 deg. C.

Before the introduction of the silicones electrical engineers recognised two classes of insulating materials, namely: class A—cotton, paper and similar organic materials impregnated or bonded with organic resins; class B—asbestos, glasscloth, mica and similar organic materials impregnated or bonded with organic resins, which have maximum operating temperatures of 105 deg. C. and 130 deg. C., respectively. The difference in the heat stability between organic varnishes and silicone varnishes has led to a third class of insulating material being established in the United States, class-H; this is defined as: asbestos, glasscloth, mica and similar inorganic materials impregnated or bonded with silicone compounds or materials with similar properties. The maximum operating temperature has been set at the conservative figure of 180 deg. C. Class-H insulation has not yet received international recognition but British firms are already manufacturing dry-type transformers, motors and other equipment to meet its specifications.

CLASS-H INSULATION FOR ELECTRIC MOTORS

A properly-constructed class-H motor or generator should have coils formed with silicone resin-bonded glass-covered wire, slot liners of glasscloth and mica bonded with silicone resin, slot wedges of rigid silicone glasscloth or asbestos laminate, coil ends taped with silicone-varnished glasscloth, and all flexible leads insulated with silicone rubber. In addition all impregnation should be carried out with a silicone varnish. The increase in operating temperature will also make it necessary to use high melting-point solders, high-temperature lubricants and heat-resisting paints. The latter two can also be silicone based.

Motors constructed in the above manner have been subjected to most rigorous testing.[2,3,4] The test cycle began with a period of operation at elevated temperatures followed by cooling to room temperature and exposure of the windings to 100 per cent. relative humidity for a 24-hour period. Subsequently, the motors were operated on load to produce high operating temperatures (200 to 300 deg. C.) for an accelerated life test. The motors were also subjected to high humidity periodically during their operation.

The conclusions reached after this investigation were :—

(1) That those motors that failed the test did so because the oxidation of the copper reduced the cross-sectional area of the conductor to such an extent that overheating occurred, and failure could not be attributed to the insulation.

(2) That silicone insulation presents less fire hazard than other classes of insulation. The failure of a motor insulated with class-B insulating materials when subjected to the same test was inevitably followed by a fire whereas the failure of a class-H motor resulted in the formation of residues (silicon dioxide) which did not burn.

(3) That class-H insulation could be expected to operate several hundred times as long as class B under conditions where thermal ageing is the primary factor in establishing insulation life.

In addition to the high thermal stability of silicone insulating materials they show good resistance to the action of water and to many corrosive chemicals. Table II shows the resistance of a typical silicone varnish to various chemicals.

The cost of insulating a motor with class-H material is 10 to 20 per cent. greater than using class-B insulation. However, where conditions are severe or when reliability is required the initial outlay is soon repaid. Fig. 2 is a photograph of a silicone-insulated stator after 4½ years pump duty on a thioglycollic-acid plant. The motor, which was an open-end type, was operated at 50 per cent. overload and under the grime the silicone varnish showed no signs of ageing Previously class-A insulation had lasted from 3 to 6 months.

Innumerable cases exist where class-H insulated motors can be of advantage to an engineer, but perhaps the most interesting is the possibility of increasing the capacity of existing equipment. Many cases occur where increased throughput is required but the installation of larger equipment is difficult, either because of space limitations or because of cost. Rewinding an existing electric motor with silicone insulation is relatively inexpensive and will allow the output of the motor to be increased, in some cases by as much as 80 per cent.

ELECTRICAL EQUIPMENT SUBJECT TO MECHANICAL SHOCK

The coils used on electro-magnets, vibrating screening tables, and similar equipment are often subjected to intermittent overloading and also to excessive vibration. In such cases silicone rubber can be used to provide a class-H in-

TABLE II.—CHEMICAL RESISTANCE OF SILICONE VARNISH

Chemical	Resistance of silicone varnish	Chemical	Resistance of silicone varnish
Acetic acid, 5 per cent.	Good	Sodium hydroxide, 50 per cent.	Good
Acetic acid, conc.	Poor	Sulphur dioxide, liquid	Poor
Acetone	Poor	Sulphur dioxide, gaseous	Good
Ammonia liquid	Poor	Sulphuric acid, 30 per cent.	Good
Ammonium hydroxide, conc.	Good	Citric acid, 5 per cent.	Good
Carbon tetrachloride	Poor	Sulphur	Good
Chlorine (gaseous)	Good	Copper sulphate, 50 per cent.	Good
Freon	Fair	Stearic acid	Poor
Gasoline	Poor	Hydrocarbons	Good
Hydrogen peroxide, 3 per cent.	Good	Phosphoric acid, conc.	Good
Hydrochloric acid, conc.	Fair	Ferric chloride	Good
Methyl chloride	Poor	Alcohol	Poor
Mineral oil	Good	Sulphuric acid, conc.	Poor
Nitric acid, 10 per cent.	Good	Toluene	Poor
Nitric acid, conc.	Poor	Stoddard solvent	Good
Sodium carbonate, 2 per cent.	Good	Water	Good
Sodium chloride, 26 per cent.	Good	Phenol	
Sodium hydroxide, 10 per cent.	Good		

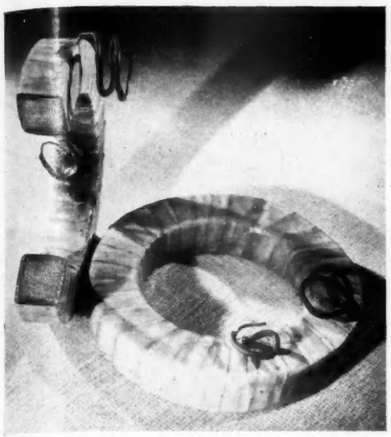


Fig. 3 Silicone rubber as a coil filler; the rubber was extruded over silicone-glasscloth insulated wire as the coil was wound, and tests showed no change in insulation resistance after immersion in water at 90 deg. C. and after repeated vibration.

sulation together with resistance to mechanical shock.

One method of using silicone rubber is in the form of a semi-vulcanised tape based on glasscloth. The tape can be used to wrap coils and similar electrical components and can be polymerised in a press or autoclave in 5 to 10 minutes at 160 deg. C. In this way layers are bonded together to form a waterproof, flexible dielectric jacket. A further advantage of this tape is that it can be readily wrapped around conductors with sharp curves without causing sagging or introducing air gaps.

A second and novel method of using silicone rubber is as a coil filler as shown in Figure 3. The silicone rubber was extruded over silicone-glasscloth insulated wire as the coil was wound. The coil was heated to 200 deg. C. for 4 hours to polymerise the rubber, wrapped with semi-vulcanised silicone-rubber tape and then coated with a silcone varnish and cured again. The insulation resistance of the coil remained unaltered after prolonged submersion in water at 90 deg. C. and after repeated vibration tests.

Although oil is a good dielectric and coolant when used in transformers its use invariably introduces a fire hazard. Recently dry-type class-H insulated transformers have been introduced to this country[5] which have overcome this difficulty. Tests have shown that this type of construction can be overloaded to the point of failure and although the silicone insulation was decomposed and an electric arc was introduced intermittently into the decomposition products no fire or explosion occurred.[6]

Another interesting application of silicone rubber is in the production of electrically heated blankets and mantles. Electrical elements are woven into asbestos or glasscloth and then embedded in silicone rubber. The finished mats are flexible, moisture proof and can be used continuously at 200 deg. C. or intermittently at 250 deg. C. Silicone rubber is also used for insulating wires and cables where long life and resistance to chemicals or to extremes of temperature are required.

GASKETS, SEALS, PUMPS, AND VALVES

Silicone rubbers are used as materials for gaskets in a great variety of applications especially where low and high temperature flexibility is required. Extra mechanical strength may be obtained by introducing reinforcing layers of glasscloth, asbestos or similar heat-stable cloths. These rubbers show a good resistance to a large range of chemicals including weak acids and bases, salt solutions, aliphatic and vegetable oils and many oxidising agents. In general, they are not suitable for use with strong acids and bases, lower hydrocarbons, aromatic oils and chlorinated solvents. An interesting property of silicone rubbers is that in many cases when they are swollen by solvents no permanent damage is done; removal from the solvent permits the rubber to regain its original dimensions and properties.

When fully polymerised, most silicone rubbers contain no toxic ingredients and may, therefore, be used in food processing and biochemical equipment. Silicone rubbers also prevent adhesion of many sticky materials, do not support the growth of fungus and can be sterilised repeatedly by steam or dry heat. Silicone rubber is also used as extruded section to seal the doors of refrigeration plant, drying ovens, furnaces and many similar applications.

The use of diaphragm pumps and valves is increasing because they permit accurate control of fluid flow and are also suitable for handling liquids with large amounts of solids in suspension. Reinforced silicone-rubber diaphragms are used where their special properties are required; and valve discs for reciprocating pumps and compressors have also been made from silicone rubber.

A silicone compound is used as a lubricant for plug cocks and valves, and as an impregnating medium for gland packings. The compound retains its grease-like consistency at temperatures from — 40 deg. to 200 deg. C., does not melt and does not break down to form a carbonaceous residue. The chemical resistance of the compound is good but it is not suitable for use in contact with aromatic solvents, chlorinated hydrocarbons, or hot concentrated nitric and sulphuric acids. It may well, however, give better service against these materials than other lubricants.

LUBRICATING OILS AND GREASES

The silicone fluids and the greases compounded from them are useful lubricants for service at high and low temperatures or in cases where semi-permanency at moderate temperatures is required. Their properties will depend upon the proportion of phenyl groups that are present in the siloxane backbone and the fillers used but an approximate classification is given in Table III.[7]

Silicone lubricants are most suitable for use in ball and roller bearings or lightly loaded metal to metal bearings. They are not satisfactory under heavy loads or where boundary lubrication is required.

Typical applications for the silicone lubricants are in stoving- and drying-oven conveyors, class-H insulated motors, textile equipment operating under hot and humid conditions and aircraft instruments.

The stability of the dimethyl fluids to heat, oxidation and mechanical shearing and their exceptionally low variation of viscosity with temperature make them ideal damping media. These fluids make it possible to manufacture a fluid friction damper that is both reliable and economical to produce. The damper consists of a flywheel that is surrounded by a closely fitting casing having a radial clearance of about 0·010 in. and a lateral clearance of up to 0·020 in. The annular space is filled with a high-viscosity silicone fluid. If the unit is suddenly rotated the flywheel will move only as far as it is dragged by the fluid so that both major and minor critical orders of vibration can be met without tuning.

Silicone fluids are also used in shock absorbers when reliability and constant performance are required over a wide range of temperatures. The damping mechanism on an aeroplane undercarriage is a typical example and silicone fluids are used for this duty on the Avro Vulcan. Similar shock absorbers, designed for operating loads of approximately 100 tons, were used on the Brabazon.

CHEMICAL APPLICATIONS

Antifoaming Agents.—The development of foam during a chemical reaction can result in loss of product, reduction in throughput, or it may necessitate the use of larger vessels than would otherwise be necessary. The dimethyl silicone fluids and compounds based on them can be used to overcome these difficulties because of their exceptional antifoaming properties. Unlike most organic additives the silicones do not prevent foaming but destroy the foam once it is formed.

Despite the relatively high price of silicone materials their use is economical because of the very low concentrations required. Typical applications use 20 to 200 parts per million but in numerous instances 1 p.p.m. is sufficient. Silicone antifoaming agents are considered to be safe for use in foods if the concentration does not exceed 10 p.p.m.,[8] but work has shown that much higher concentrations[9] than this may be taken orally without ill effects.

Typical applications of these products are widespread but some of the more interesting are, the concentration of molasses, whisky and caustic soda, the preparation of plastic emulsion paints, the processing of organic resins, the transport of bitumen and tars and the preparation of many pharmaceuticals.

Vessel Lining.—It is not possible at present to line vessels with silicone rubber in the way that organic rubbers are used because of the extensive cure and the pressure required to obtain satisfactory bonding to the metal. This difficulty can be overcome for small vessels by using a sectional construction. The silicone rubber can be bonded to the metal in a press and the flat sheet can then be shaped to the desired section. The size of the sheets, however, is limited by the size of press that is available and is usually restricted to 6 ft. square.

Heat-Transfer Fluids.—For specialised applications the silicone fluids are ideal heat-transfer fluids. They can withstand high temperatures for long periods without change in properties, they do not form sludges, have reasonable heat-transfer properties, very low vapour pressures and present no fire hazard. Despite their attractive properties, however, the high initial cost of silicone fluids has restricted their use to pilot plant and laboratory work.

Release Agents.—The incompatibility of silicone fluids makes them suitable for preventing sticking when moulding or casting rubber, plastics and metals. For example, the traditional release agents used when moulding car tyres were organic waxes, graphite and French chalk. All of these materials decompose at moulding temperatures and result in loss of time for cleaning, and unpleasant working conditions. A thin layer of a silicone fluid performs the same task both economically and cleanly. For most applications the silicone fluid is used as a water emulsion and in this form dilutions of 1 part of siloxane to 300 parts of water are effective.

Silicone-treated paper is available which, because of its non-adhesive properties, finds many uses as an interleaving and wrapping material. Typical applications are the lining

TABLE III.—Classification of Silicone Lubricants

Physical state	Phenyl content	Thickening agent	Viscosity range in centistokes at 77 deg. F.	Consistency range A.S.T.M. penetration	Useful temperature range, deg. F.
Fluid	None	—	0·65 to 1,000,000	—	— 125 to 350
Fluid	Low	—	50 to 60,000	—	— 100 to 400
Fluid	Medium	—	100 to 150	—	— 58 to 500
Fluid	High	—	500	—	— 8 to 500
Grease	None	Silica	—	220 to 250	— 60 to 400
Grease	Low	Lithium soap	—	200 to 380	— 100 to 300
Grease	Medium	Lithium soap	—	200 to 380	— 40 to 400
Grease	High	Carbon black	—	260 to 300	— 20 to 500

of packages containing sticky substances such as bitumen, asphalt, glue, resins and waxes and in the wrapping of cakes and sweets. The treated paper is also water repellent and this property has been utilised in a petrol filter. The petrol wets the paper and passes through it readily, yet the water is retained.

PROTECTIVE COATINGS

The silicone and silicone modified resins previously described can be used to prepare paints which have properties between those of organic finishes and vitreous enamels. Heat-stable pigments can be added to give a wide variety of colours and the addition of a metallic drier such as zinc or cobalt octoate will accelerate the polymerisation of the resin.

When using a silicone-based paint it is most essential that the surface to which it is to be applied is absolutely clean. All grease and rust must be removed by solvents, pickling, or even sand blasting. This is particularly necessary with steel because of the danger of forming a non-adhering film under the paint when the temperature exceeds 200 deg. C. Silicone paints can best be applied by spraying, but dipping or roller coating may also be used. Brushing is not recommended because of poor levelling characteristics. Polymerisation times will depend upon the formulation, but most silicone based paints will require a cure at 200 deg. C. for at least 4 hours. Paints based on silicone-organic mixtures will, however, polymerise at a lower temperature and in some cases will be satisfactory for use after air drying at room temperature.

As measured by a knife scratch, the adhesion of silicone-based paints to aluminium, magnesium and tin is satisfactory. However, to obtain satisfactory adhesion to steel, particular care must be taken in the preparation of the surface. Although resistance to high temperature is the principal characteristic of silicone paints they are also unattacked by many chemicals, particularly at ordinary temperatures. This applies to acids, alkalis, salt solutions and various oils but resistance to organic solvents is not good.

The silicone paints described above are suitable for use up to temperatures of 250 deg. C. but protection at temperatures up to 500 deg. C. can be obtained if a combination of organic and silicone resins is used, with aluminium paste as the pigment. Curing temperatures of 400 deg. C. are necessary to obtain the optimum properties with this formulation. Both the organic and silicone resins will decompose at this temperature and they would appear to act as carriers to enable the aluminium to weld to the surface. The final result is a firmly adhering coating of aluminium that will withstand repeated cooling and heating.

Another silicone product can be used to render brick, mortar, concrete, asbestos cement, sandstone and limestone water repellent. The treatment coats the pores of the masonry with a thin water-repellent film which does not alter the appearance or " breathing " characteristics of the surface. The film, however, is not waterproof and is not recommended for use below ground level or in places where any hydrostatic pressure exists.

Similar silicone treatments exist for textiles and leather but at the present time their engineering applications depend more upon properties other than water repellency. For example, silicone-treated leather is relatively unaffected by jet aircraft fuels and remains flexible at − 75 deg. C. Also, silicone-treated cyclone filter bags can be used at higher temperatures than normal and there is less tendency for dust to stick to them.

Although it has not been possible to provide more than a brief introduction to the technology of the silicones it is hoped that their versatility has been demonstrated. It is anticipated that their exceptional properties will lead to many new developments, particularly in view of the increasing demand for equipment that can operate under conditions causing rapid deterioration of traditional materials.

In conclusion, grateful acknowledgment is made to Midland Silicones, Limited, for their assistance in the production of this article.

REFERENCES

[1] Anon, " Silicones Shoulder their Way into the Big Time," *Chem. and Eng. News*, vol. 31 (No. 20), page 2074 (1953).

[2] W. J. Renwick, J. R. Reed, " Silicone Resins, Fluids and Elastomers in Insulation for Use at Power Frequencies," *Proc. I.E.E.*, vol. 100 (Part 2A, No. 3), page 239 (1953).

[3] G. L. Moses, " Thermal Endurance of Silicone Motor Insulation," *Westinghouse Engineer*, vol. 9, page 168 (1949).

[4] G. Grant, T. A. Kauppi, G. L. Moses and G. P. Gibson, " Motor Tests Evaluate Thermal Endurance of Class H Insulation and Silicone Varnish," *Trans. A.I.E.E.*, vol. 68 (Part 2), page 1133 (1949).

[5] Anon., " Class H Insulated Transformers," *The Electrical Journal*, vol. 152 (25), page 2055 (1954).

[6] E. W. Tipton, " Sealed Dry Type Transformers Proved Safe by Test," *Trans. A.I.E.E.*, vol. 72, Part 3 (7), page 843 (1953).

[7] G. Grant and C. C. Currie, " Properties and Performance of Silicone Lubricants," *Mechanical Engineering*, April, page 311 (1951).

[8] A. J. Lehman, " Some Toxicological Reasons Why Certain Chemicals May or May Not Be Permitted as Food Additives," *Bull. Assoc. Food and Drugs Officials of the U.S.*, vol. 14 (3), page 82 (1950).

[9] V. K. Rowe, H. C. Spencer and S. L. Bass, " Toxicological Studies on Certain Commercial Silicones, II.—Two Year Dietary Feeding of D.C. Antifoam A to Rats," *Archives of Industrial Hyg. and Occup. Med.*, vol. 1, page 539 (1950).

SYNCHROS FOR DATA TRANSMISSION

By F. G. Helps, B.SC.TECH., A.M.I.E.E.*

The transmission of information quickly and accurately is an object of, and a stimulus to, technical development. Every improvement in data transmission makes possible improvements in a wide field of engineering. Process control in chemical plant and servo-control systems in general rely on every small change of any variable being detected and transmitted to the appropriate controller. The petrol gauge on a motor car is a typical example of a data transmission system. The problem in this case is that of indicating to the driver the level of petrol in a remote storage tank. The particular solution consists of employing a float on the surface of the petrol, which by means of a pivoted arm, moves a sliding contact along an electrical resistance element. The variation of the electrical resistance with petrol level is indicated by a suitable meter on the dashboard. There are many other solutions to such a problem, but the use of electrical methods of data transmission has advantages over mechanical methods for distances greater than a few feet, and is especially valuable when a mechanical drive would involve awkward gearing, or a complicated system of levers and thrust rods. Where the information has to be transmitted several hundreds of yards the electrical solution is the only practical one.

The petrol gauge data transmission system can be simple and cheap since high accuracy is not required, and the pivoted arm carrying the float does not rotate more than a few degrees. The problem becomes more difficult when angular movements throughout 360 deg. have to be transmitted with an accuracy of the order of one tenth of a degree. Such problems are encountered, for example, when designing the fire control equipment for a gun turret. Accuracies of a slightly lower order are required in compass-heading information transmission systems for driving compass repeaters in ships and aircraft, for transmitting the position of a rotating radar scanner, for steering control in ships, for transmitting the position of rotating objects in machine tools, for transmitting the position of lock gates and sluice valves, and in a large number of servo controlled mechanisms. Linear motion can easily be converted to angular motion by rack and pinion or by cord and pulley, and a still wider field of application is open to data transmission devices capable of transmitting angular motion.

There are several devices which convert mechanical movement to electrical information. Where angular information has to be transmitted it is generally most convenient to employ a device called a " synchro," a generic term accepted by the British Standards Institution. Synchros are manufactured under a variety of trade names such as Selsyn, Teletorque, Magslip, Telesyn, Asynn, Autosyn, etc.

The method used in data transmission employing synchros is as follows: 1. Where the information to be transmitted is not already in the form of rotational movement, it is converted to rotational movement by cord and pulley, rack and pinions or crank and lever, etc. 2. The rotational movement is coupled to the shaft of the transmitting synchro which converts the mechanical movement into related electrical voltages. 3. The transmitting synchro is connected by leads of suitable length to a receiving synchro which is located at the point where the information is required. The electrical voltages are then converted back to mechanical movement.

A synchro may not be the most accurate method of transmitting information over dis-

* Sperry Gyroscope Company, Limited.

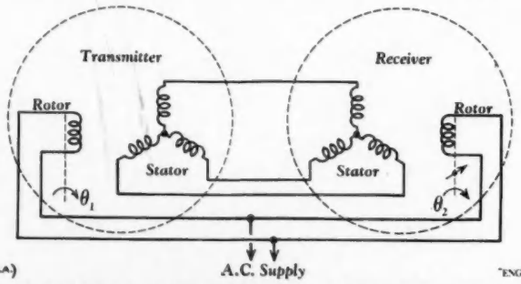


Fig. 1 Principle of torque transmission. Normally the transmitter rotor is held mechanically, and the receiver rotor is free to turn so that it aligns itself with the transmitter.

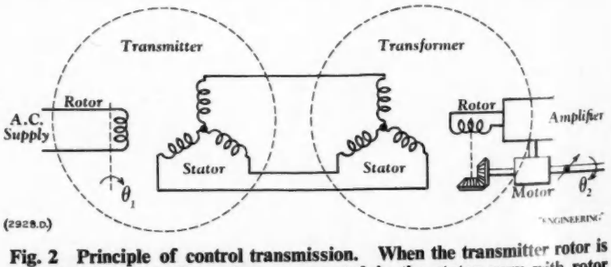
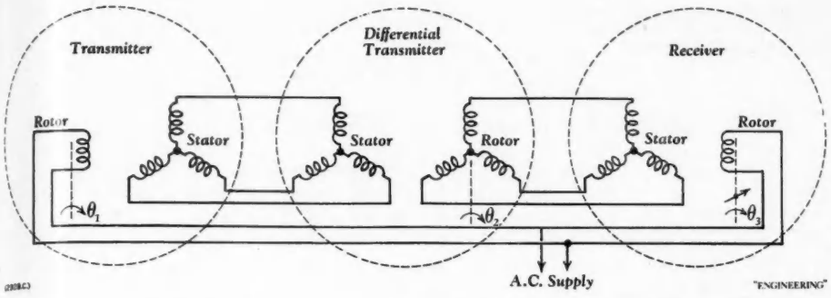
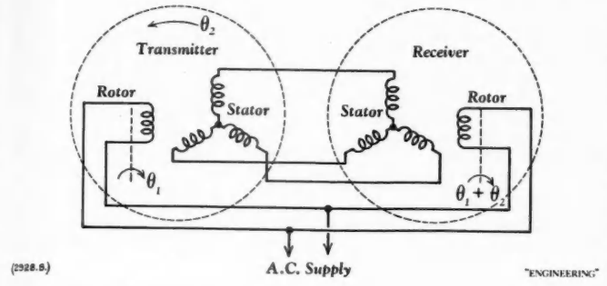


Fig. 2 Principle of control transmission. When the transmitter rotor is energised the three line voltages generated in the stator vary with rotor position and cause a voltage to be generated in the transformer rotor, which is amplified and fed to a servo-control mechanism which also drives the transformer rotor in the direction to cancel out the signal.





Figs. 3 and 4 Principle of differential transmission; alternative methods. In Fig. 3, a torque differential transmitter is inserted into a simple transmission train. In the method of Fig. 4 the transmitter housing is rotated through an angle $-\theta_2$ and the shaft through an angle θ_1, resulting in the torque receiver shaft rotating through $\theta_1 + \theta_2$.

tances of several miles. Some form of coding of the information in the form of electrical pulses may then be more convenient.

CONSTRUCTION

In construction a synchro resembles an electric motor or generator. The body, which is provided with suitable means for mounting, contains a stator of laminated iron carrying windings in slots. The rotor, which is carried by ball-bearings and rotates within the stator, is also of laminated iron and also carries windings in slots. The rotor windings are connected to terminals on the housing via slip rings and brushes. The windings may have one, two or three groups of coils similar to a one-, two- or three-phase winding on an alternator.

Electrically a synchro is similar to an electrical transformer. When, for example, the rotor is energised with alternating current, an alternating magnetic flux is produced which indices voltages in the stator windings. The voltage induced in any winding on the stator will depend upon the position of the rotor relative to the stator windings.

It will be noted that, unlike a generator, synchros are excited with alternating current, and an output is obtained even when the rotor is stationary. Also, whereas in an alternator the voltages induced in the different windings are of different time-phase relationship, the voltages induced in synchro windings are all in phase, and it is the amplitudes of these different voltages which are modulated by the position of the rotor. In order to distinguish the windings in synchros from the time-phase windings in alternators, synchro windings are said to have a "space phase" distribution.

Synchros can be considered as falling into three distinct categories: torque elements, control elements, and resolver elements.

TORQUE SYNCHROS

Torque elements are employed for the transmission of angular position information electrically and for the reproduction of this information by the position of the shaft of the receiver element. Misalignment between the shafts of the transmitter and receiver elements increases with the load on the receiver and for this reason these elements give the highest accuracy when driving balanced indicator pointers of small inertia. The system is not power-amplifying and hence any load driven by the receiver is reflected back to the mechanism driving the transmitter.

Both transmitter and receiver have three space-phase stator windings and single-phase energising windings on the rotors.

Receivers can either be of the torque receiver type, or the torque indicator type. In both cases the stators are of similar construction and are connected to the transmitter unit, but the rotors differ in electrical and mechanical arrangements. The torque receiver has a wound rotor energised via slip rings from the supply. It is a more powerful unit than the torque indicator, which has a light iron rotor magnetically polarised by stationary coils.

The principle of the torque transmission system is as follows. The rotors of both transmitter and receiver are energised from the alternating-current supply and produce an alternating flux in their corresponding stators. Should the relative dispositions of rotor to stator in the two elements be different, the three voltages created in each of the two stator windings by the alternating fluxes differ, current flows in the leads connecting them, and a torque is produced in each synchro which is so directed as to eliminate the discrepancy and, in effect, to align the two rotors.

Normally, the transmitter rotor is held by mechanical means, e.g., pinion and gear, and the receiver rotor is free to turn so that it aligns itself with the transmitter. Thus, in Fig. 1, any movement of the transmitter rotor will be repeated synchronously by the movement of the receiver rotor.

Multiple Indication.—It is possible to have two or more receivers with their stators connected in parallel and connected to one transmitter, but, in general, additional receivers are liable to impair the accuracy of the system unless special precautions are taken. Misalignment due to excessive load on one receiver is reflected back into the system and affects the accuracy of all other receivers. This mutual interference can be reduced by using receivers with higher stator impedances. Similarly, the number of receivers which can be operated also depends on the size of the transmitter. The torque indicators have been specially designed to enable several to be driven from one torque transmitter.

Differential Transmission.—If two angles are to be transmitted, the difference or sum of which is to be shown at the receiving end, a torque differential transmitter is inserted into a simple transmission chain. The differential transmitter has a three space-phase star-connected rotor and stator. Its stator is connected to the stator of the transmitter and its rotor is connected to the stator of the receiver (Fig. 3).

The angles transmitted, θ_1 and θ_2, may be added or subtracted by reversing any two interconnecting stator leads, the resultant angle θ_3 appearing at the receiver.

An alternative method is to employ only a torque receiver and torque transmitter. If the housing of the transmitter is rotated through an angle θ_2 and the shaft by an angle θ_1, the shaft of the torque receiver will rotate by the sum or difference of θ_1 and θ_2 (Fig. 4).

CONTROL SYNCHROS

Control elements are employed in a data transmission system where a powered output is required to drive a mechanism which may have large inertia or require a greater torque than can be provided by a torque element. This may be a searchlight or directional antenna array on a turntable, or a gear train controlling a sluice valve, or any instance where remote control of the position of mechanism is required. A number of separate mechanisms at points remote from the transmitter may be controlled simultaneously.

As in the case of torque transmission, the rotor of the control transmitter is energised from the alternating current supply (Fig. 2). The receiving element is called a control transformer, and the rotor is not energised but feeds an electronic amplifier. Both transmitter and transformer have a single phase rotor and a three-space-phase stator.

When the rotor of the transmitter is energised the three line voltages generated in the stator vary with the rotor position. These voltages supplied to the stator of the control transformer reproduce the direction of the alternating transmitter flux, and by transformer action a voltage is generated in the rotor. This signal voltage generated in the control transformer is amplified electronically. It is fed to a servo motor which drives the mechanism to be controlled and also the rotor of the control transformer. The rotor is driven to a position at right angles to the flux reproduced in the control transformer, when zero voltage is generated in the rotor winding and the servo motor comes to rest. Any change in the position of the transmitter rotor alters the direction of the flux in the control transformer, and a signal voltage is produced in the control transformer until the servo-motor re-nulls the rotor. Ambiguity of rotation is avoided by phase discrimination in either the amplifier or servo motor. In the latter case a two-phase induction motor is used.

The output power of such a system depends solely upon the power output of the amplifier and servo motor. By means of control synchros, very small units and light controlling forces can operate heavy mechanisms remote from the control point.

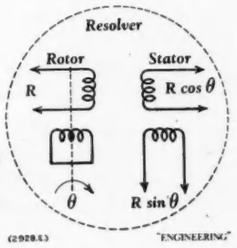


Fig. 5 Resolution of polar to Cartesian co-ordinates.

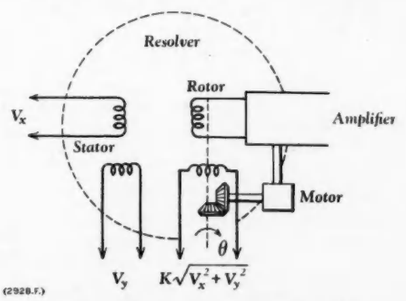


Fig. 6 Resolution of Cartesian to polar co-ordinates.

In a similar manner to that described for torque synchros, the sum or difference of two angles may be transmitted by the use of control differential transmitters.

RESOLVER SYNCHROS

Resolver synchros are employed to convert voltages, representing Cartesian co-ordinates, to a shaft position and voltage representing polar co-ordinates, or vice-versa. They have a two-space-phase winding on both rotor and stator.

Resolution: Polar to Cartesian Coordinates.—If in Fig. 5 an alternating voltage R represents the modulus of a polar co-ordinate and a shaft displacement θ the argument, then the voltages appearing at the stator terminals are R cos θ and R sin θ, i.e., the Cartesian co-ordinates of the polar vector Rθ. Accuracy is improved if the unused primary winding is short-circuited as this reduces any cross axis magnetic flux.

Resolution: Cartesian to Polar Co-ordinates.—To convert Cartesian to polar co-ordinates a servo nulling device is required. An alternating flux of amplitude and direction dependent upon the voltages V_x and V_y representing the Cartesian co-ordinate is produced when these voltages are applied to the two stator windings. (Fig. 6.)

One of the rotor windings is connected to an amplifier and servo motor and drives the rotor to a null position when no voltage appears across this winding. The other rotor winding is then in line with the flux axis, and has induced in it a voltage proportional to the amplitude of the alternating flux, i.e., proportional to $\sqrt{V_x^2 + V_y^2}$. This voltage represents the modulus R. The shaft position represents the argument θ of the polar co-ordinates equivalent to the Cartesian co-ordinates V_x and V_y, i.e., $\tan^{-1}\frac{V_x}{V_y}$.

Data Transmission using Resolvers.—In some instances it is more convenient to have positional information transmitted in Cartesian co-ordinates. The information is then readily available for application to the horizontal and vertical plates of an oscilloscope or for modification by other computer elements. Such instances occur, for example, when transmitting the position of a radar scanner.

Resolver as a Phase Shift Device.—A resolver can be used as a phase shifting device in conjunction with a resistor in series with a matched capacitor across both stator phases. If the rotor is energised, a voltage can be obtained between the common point of both stator phases and a point between the resistor and capacitor, the phase of which can be varied through 360 deg. by turning the rotor (Fig. 7).

Differential Resolution.—It is sometimes necessary to obtain the sine and cosine values of the sum or difference of two angles. Such instances occur, for example, when the position of a radar scanner in an aircraft is required relative to north in Cartesian co-ordinates, hence, in Fig. 8, θ_1 = radar scanner position, θ_2 = aircraft heading.

SPECIAL PURPOSE SYNCHROS

In addition to the synchro functions already described, synchros can be designed to perform many special functions. They can be used, for example, as varying-frequency modulators of a carrier signal, as phase computers to indicate the phase of a signal, and also to perform special functions in analogue computers. Most of these applications require that the synchros shall be specially designed for the equipment in which they will operate.

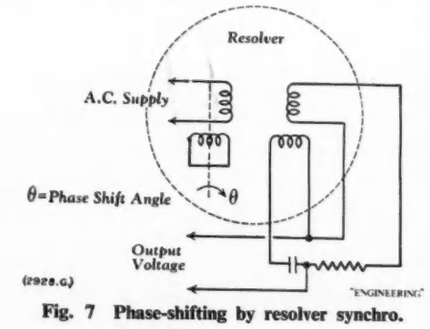
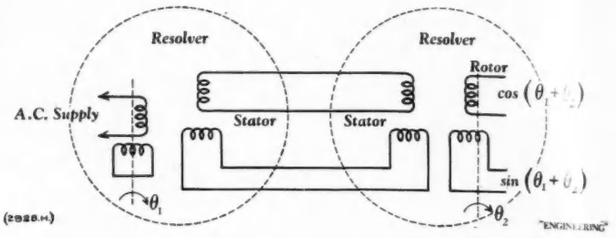


Fig. 7 Phase-shifting by resolver synchro.

Fig. 8 Differential resolution by resolver synchro.



Phase as a Means of Transmitting Position Information.—The resolver phase shifter described above produces a signal whose time phase depends upon the position of the rotor. Hence, it is possible to transmit angular information in terms of the time phase of an alternating signal with respect to the phase of a reference signal.

CHOICE OF SYNCHRO

The choice of the correct type of synchro from the large range available is no easy matter. It is generally advisable to consult the manufacturer who will suggest the most suitable model. The performance of a synchro depends very much upon the way it is used, and the type of loads and couplings employed. Performance figures quoted generally relate to the operation of the synchro under certain specified conditions.

Torque Synchro Characteristics.—The performance of torque elements is usually quoted for a chain of two synchros, one transmitter and one receiver. The receiver synchro carries no load, or only a light pointer of small inertia.

The torque available from a chain of torque elements increases sinusoidally with misalignment between transmitter and receiver rotors. The torque is usually quoted in terms of the gradient of this sinusoid close to the aligned, or zero torque, position, in gm.-cm. or lb.-in. per degree. Torques of several lb.-in. per degree are possible with the larger torque synchros such as are employed in theatre lighting control.

Damping devices are often built into torque synchros to reduce the overshoot and oscillations of the receiver when the transmitter is displaced. With no added loads the time for the synchro to come to rest after a displacement of 180 deg. is usually less than two seconds.

Most torque synchros are rated for continuous operation. Some models are limited to driving a fixed maximum load, for example, a load which is limited so that the unit does not operate continuously with a misalignment greater than, say, 20 deg. Too great a load will, of course, cause the receiving synchro to drop out of synchronism with the transmitter.

Control Synchro Characteristics.—It is possible to specify the accuracy of a single control synchro in terms of the maximum discrepancy between the shaft position and the information transmitted electrically representing this shaft position. In an ideal control synchro the electrical information would truly represent the shaft position and the error would be zero.

Accuracies of the order of $\pm \frac{1}{2}$ deg. are quite easily achieved and modern synchros have accuracies as high as $\pm \frac{1}{10}$ deg. If higher accuracies are required it is necessary to gear the synchros to the drive and output shaft. In this case the errors are reduced by the ratio of the gearing. For example, if a gear ratio of 60 to 1 is employed the maximum error would be reduced by $\frac{1}{60}$ of the synchro error. Unfortunately, there would be 60 possible positions of the output shaft for every position of the transmitting synchro, only one of which would be correct. In order to get over this problem of lack of synchronism, it is necessary to employ two data channels, one channel geared 1-to-1 to maintain synchronism, the other channel with a higher gear ratio to position the output accurately when the first channel has approximately positioned the output. Such a system is known as "coarse and fine transmission."

When dealing with high-accuracy data transmission systems the limiting factors are often the errors in the gearing and associated mechanical components rather than in the synchros themselves. The stability and power of a control system depends upon the design of the follow-up servo amplifier and not upon the synchro.

Resolver Synchro Characteristics.—There are many ways of defining synchro resolver performance. The purpose for which the unit is employed decides the most convenient form of expressing the characteristics. The following figures give some idea, however, of the accuracies obtainable: angular displacement between two phase windings, 90 deg. $\pm$ 4 min; output voltage departs from true sinusoid less than 0·1 per cent. and accuracy obtainable with the unit employed as control element, $\pm$ 6 min.

MOUNTING SYNCHROS

Synchros may be mounted either by bolts through "feet" on the stator, or may be flange mounted. In the latter case an accurately-machined spigot on the synchro positions the gear on the synchro shaft so that it meshes correctly with the driving mechanism. The mounting bolts and clamp must be strong enough to support the synchro under the most severe vibrations that will be encountered. Care should be taken when mounting synchros to use methods which do not distort or stress the stator since this would impair the accuracy of the unit.

Where space is restricted, control units an inch in diameter and approximately $1\frac{3}{4}$ in. long, weighing 3 oz. are available which are capable of achieving accuracies of $\pm$ 7 minutes of arc.

In some mechanisms it is not possible to mount conventional synchros, but separate rotors and stators can be more easily built into the structure of the equipment. Such problems as the transmission of gimbal-axis position are best treated in this way. These separate elements are also useful when co-axial shafts are required or when a number of rotors have to be driven at the same speed.

Although synchros are not new (one patent describing a type used to-day dates from 1897), in recent years the applications for synchros have increased considerably. As a result, much attention is being paid to the development of small, very accurate, and reliable elements. Each application, however, raises problems of its own and work in this field is by no means at an end.

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MAKING FARM MACHINERY SAFE

Preparation of Codes

At the request of the Council of the Institution of British Agricultural Engineers the East Anglian Centre is investigating the preparation of a safety code or codes for farm machinery. The codes will apply to employers and operators, and recommendations will be made to manufacturers and designers where necessary. These recommendations will concern alterations in general design or the provision of additional safety guards, where it is felt that they would help to reduce the number of accidents by eliminating dangerous practices or danger spots in agricultural machines.

BRITISH INSTRUMENT INDUSTRIES' EXHIBITION

INDICATION AND CONTROL OF PROCESSES

The third British Instrument Industries' Exhibition is to be held at Earls Court, London, S.W.5, from Tuesday, June 28 to Saturday, July 9, and a wide range of scientific and electrical instruments, industrial meters, automatic controls, scientific glassware and drawing-office equipment will be on display. Of special interest will be a vapour phase chromatographic unit; equipment for the detection of smoke and fog, and the maintenance of economic furnace conditions; electronic digital computers; a new planimeter; special apparatus for the automatic control of chemical and oil-refining processes; and a Moiré technique for strain analysis. Many of these items and certain others are described in the following article. Further information about the exhibition, including details of a number of lectures and conferences, are given in a Weekly Survey note.

VAPOUR PHASE CHROMATOGRAPHY

An item of special interest to be exhibited by Griffin and George Limited, Ealing-road, Alperton, Wembley, Middlesex, is their vapour phase chromatographic apparatus; but in addition they will be showing electrochemical apparatus for the gravimetric analysis of metals and alloys; a mercury cathode unit for determining small quantities of aluminium, vanadium, titanium and zirconium in high-chromium and other alloy steels; an autopoise centrifuge; atomic models; a universal micro and semi-micro combustion train; a diffusion cloud chamber; various resistance, capacitance and inductance units; and a water de-ioniser.

The Griffin-B.D.H. Water Deioniser is a compact all-glass unit for the production of high-purity (pH 7) water, and contains a mixed-resin bed 12 in. in depth. When used with once-distilled water the bed can pass many thousands of litres before requiring regeneration. The unit is fitted with a dual-purpose stand for either bench or wall mounting, and a conductivity cell and indicating unit may be incorporated to give continuous indication of the conductivity of water.

Figs. 1 and 2 show respectively the Griffin vapour phase chromatographic apparatus and a diagrammatic layout of its functional parts. It is a recently developed unit which can be used for the analysis of mixtures of liquids, of medium molecular weights, which vaporise between 20 deg. C. and 200 deg. C. at atmospheric pressure. With close control it can give repeatable quantitative results, and by the addition of ancillary apparatus, analyses of gaseous mixtures may be performed.

Among the advantages of a unit of this kind over other forms of analysis are the small sample volumes required (about 0·05 ml. for a complete quantitative analysis of its constituents) and also the speed of working: results can be obtained in from 10 to 45 minutes recorded in graphical form. In addition, the same column can be re-used immediately many hundreds of times without changing the packing. Retention time or retention volume under identical temperature and nitrogen flow rates may be used to identify substances, while the retention time of members of a homologous series may be predicted when the behaviour of two or more members of the series are known. The boundaries between consecutive fractions are well defined, and a variety of stationary phases may be employed for holding back selected compounds, such as azeotropic or closely boiling substances (for example, benzene boiling at 80·1 deg. C. and cyclohexane at 80·8 deg. C.).

The apparatus operates in the following manner. Nitrogen from a cylinder fitted with reducing and fine-control valves passes through a constant-pressure regulator A (Fig. 2), charged with di-butyl phthalate, to a buffer vessel B which steadies any gas surges and traps any liquid coming from flowmeter F. A needle valve D controls the flow of nitrogen and hence the inlet pressure of the column measured on the manometer E. The gas next passes through the reference limb of a differential thermal-conductivity cell (katharometer K), through a packed chromatographic column, enclosed in an electrically-heated glass jacket and thence, with the fraction separated, to the measuring limb of the katharometer.

Each katharometer limb contains a fine, heated, platinum wire and these form two arms of an electrical bridge circuit initially balanced. Since the thermal conductivity of nitrogen plus fraction differs from that of nitrogen alone, the rate of heat loss from the second wire differs from that of the first. Its resistance therefore changes and the bridge becomes unbalanced. This out-of-balance E.M.F. is applied to a recording potentiometer, where it is amplified and appears on the chart as an eluted peak.

A needle valve D and a vacuum-release stop-cock control the efflux gas and vapours, which are extracted through a buffer vessel M by a vacuum pump with outlet pressure measured on manometer E.

The column consists of a heat-resisting glass U-tube, ¼ in. in bore, with each arm 36 in. long, which is contained in a glass tube wound with a helix of nichrome wire having a loading of some 200 watts; the whole unit is surrounded by a second wider jacket and supported top and bottom. The widened inlet limb of the column is wound with a 3·5-watt "flash heater" to volatilise liquids immediately on introduction, which is carried out through a fitted self-sealing vaccine cap. A mixture of kieselguhr and di-nonyl phthalate is employed as a general-purpose packing when water is absent. A second column packed with kieselguhr and glycerol can be used when water is present in the mixture, while triethanolamine has been found suitable for separating amines.

The katharometer comprises a differential-pattern thermal-conductivity cell with two cell units mounted in a Sindanyo-covered Duralumin block on a 350-watt heater, which can maintain the katharometer block temperature at approximately 100 deg. C. The cell units contain platinum wires heated to a temperature about 100 deg. C. above that of the block by a current of up to 200 mA from a 6-volt battery; condensation on the wires is thus avoided. The conductivity cells are connected to the system by narrow-bore metal tubing to minimise dead-space. A single-record electronic strip chart records the

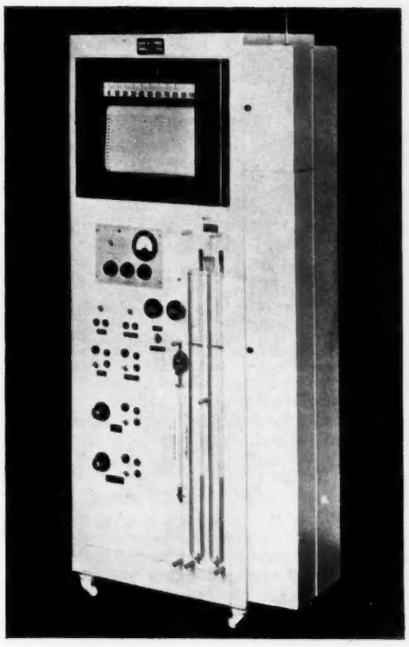

Fig. 1 The Griffin vapour-phase chromatographic apparatus can analyse mixtures of liquids of medium molecular weights, which vaporise between 20 deg. C. and 200 deg. C. at atmospheric pressure. Repeatable quantitative results may be obtained.

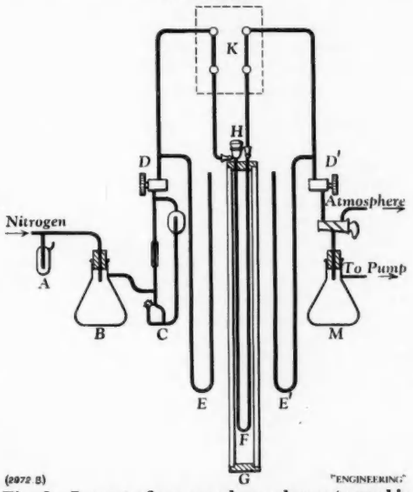

Fig. 2 Layout of vapour-phase chromatographic apparatus, which with the addition of ancillary equipment can also analyse gaseous mixtures. A flow of nitrogen separates the constituent vapours, which are determined thermo-electrically.

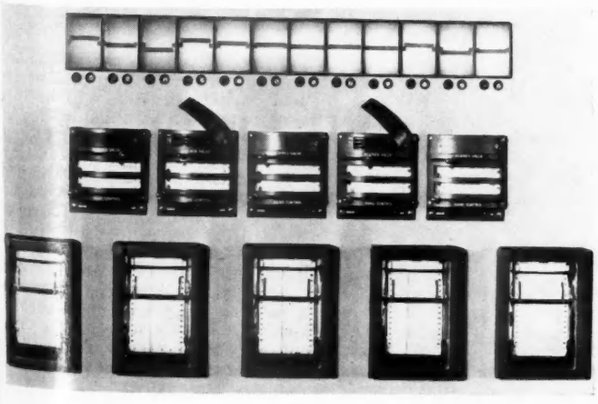

Fig. 3 The Evershed "in-line" scanner incorporates a number of shadow-type indicators mounted in line. Displacements from centre represent disparities between measured and desired conditions in a process and thus the stability of a plant may be instantly recognised.

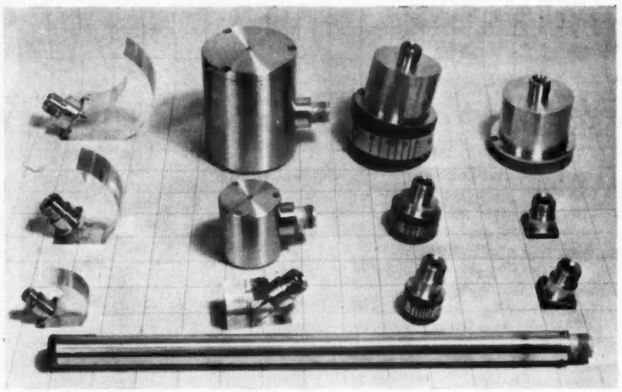

Fig. 4 Ultrasonic probes with many different applications have been developed for use with the Ultrasonoscope flaw detector; that at the bottom of the illustration, for example, is used for testing a sample immersed in liquid, thus dispensing with the need for contact between probe and specimen. A key for identifying the probes illustrated is given in the text.

out-of-balance potential of the katharometer bridge circuit.

IN-LINE SCANNER AND FURNACE CONTROL

The application of electronic control apparatus to petroleum and chemical plants, steelworks, power stations and similar industrial installations is becoming increasingly widespread, and Evershed and Vignoles, Limited, Acton Lane Works, Chiswick, London, W.4, are displaying on their stand a complete range of instruments for the measurement and control of temperature, flow and pressure (of air and other gases, steam and liquids), and liquid levels. Of particular note are valve positioners for air-fuel ratio control, an electronic ratio computer for three-element boiler regulation, a jet-pipe controller, an "in-line" scanner, and a thermo-couple repeater.

The Evershed thermo-couple repeater is a temperature transmitter, which translates a small potential, such as those encountered in pyrometry, into a proportional electric current of suitable magnitude for the operation of indicating, recording and controlling equipment. An input of the order of 10 millivolts, generated by a thermo-couple, results in an output of 30 milliamps direct current, which is delivered to a load of up to 750 ohms. The input resistance is very high and the resistance of the thermo-couple circuit is in no way critical.

An instrument designed to regulate the temperature of oil-fired furnaces is the Evershed hydraulic jet-pipe controller, which operates by controlling the flow of fuel-oil to the furnace burner. It incorporates an electro-magnetic head which is energised from the amplified output of a thermo-couple or radiation pyrometer measuring the furnace roof temperature. An armature within the head is coupled to a jet pipe, which in turn controls the oil supply to an operating piston, and the piston is arranged to adjust a control valve in the fuel-oil line to the burner. The temperature required is set by means of a knob.

Fig. 3 shows an instrument desk which employs an unusual form of presentation known as an "in-line" scanner. This consists of shadow-type indicators arranged close together so that the pointer shadows form a continuous line. Each indicator is provided with a centre zero movement, through which pass the measured-value and desired-value currents in opposition, and if the two currents are equal, the shadow pointer takes up a position in the centre of the scale. With a number of indicators so mounted, it is possible to show a continuous line, from which the stability of the plant may be seen at a glance; any deviation from normal conditions is immediately apparent. Also mounted on the desk are miniature indicators and recorders, and automatic or manual control stations.

FLAW-DETECTION PROBES

The Ultrasonoscope Company (London), Limited, and Glass Developments, Limited, Sudbourne-road, Brixton-hill, London, S.W.2, are making use of a joint stand, on which will be shown a variety of flaw-detection equipment, including numerous kinds of probe; an improved version of the Ultrasonoscope; and the operation of ultrasonic nickel-tube delay lines, in which the delay is 2 microseconds per cm. travel and the temperature coefficient about 0·016 per cent. per deg. C. (Ultrasonoscope Company). Glass Developments will display a differential gear unit of high accuracy; a distillation column for petroleum research; and examples of precision engineering work and specialised glassware.

The Glass Developments distillation column has been constructed for the Research Station of the British Petroleum Company, Limited, and is intended for the separation and analysis of complex petroleum distillations. It is designed for use with various types of "dumped" packings and, with a metal packing of the Dixon gauze-ring pattern, the separation efficiency is over 100 theoretical plates. For the fractionation of materials affected by contact with metal, glass helices may be employed, when an efficiency of 50 plates is obtained. Operation at reduced pressure enables compounds having normal boiling points up to 300 deg. C. to be distilled, while a vapour-dividing still head allows azeotropes which separate into two phases on condensation to be handled.

The versatility of ultrasonic flaw-detection techniques will be well illustrated by a wide range of special and general-purpose probes. Among these will be transverse-wave probes for use on sections down to $\frac{1}{16}$ in. thick, and variable-angle low-frequency probes employing barium-titanate discs with a resonant frequency of 410 kilocycles per second. These are intended for use on coarse-grained materials, and have been successfully employed on cast-steel base rolls, copper and brass billets, refractory blocks, and on P.V.C. and rubber-covered belting for the detection of ply separation. A demonstration will also be given of ultrasonic flaw detection where the sample is completely immersed in a liquid. This technique dispenses with the need for close contact between probe and specimen and thus overcomes some of the major obstacles in the automatic and rapid inspection of large areas. A number of these probes are shown in Fig. 4, and may be identified with the aid of the accompanying key.

Key for identifying ultrasonic probes shown in Fig. 4.

1	4	7	10
2	5	8	11
3	6	9	12
		13	

1. 2½-Mc/s 70-deg. slipper probe, 15 mm.
2. 2½-Mc/s 45-deg. slipper probe, 15 mm.
3. 2½-Mc/s 45-deg. slipper probe, 10 mm.
4. ½-Mc/s single normal probe, 45 mm.
5. 2½-Mc/s single normal probe, 23 mm.
6. 2½-Mc/s 45-deg. 15-mm. probe, one of pair.
7. ½-Mc/s steerable beam (variable-angle) probe, 45 mm., one of pair.
8. 2½-Mc/s steerable-beam probe, 23 mm., one of pair.
9. 2½-Mc/s steerable-beam probe, 15 mm., one of pair.
10. ½-Mc/s normal probe, 45 mm., one of pair.
11. 2½-Mc/s normal probe, 15 mm., one of pair.
12. 2½-Mc/s 30-deg. probe, 15 mm., one of pair.
13. 5-Mc/s immersion testing probe.

Improvements in the Ultrasonoscope itself include the use of a post-deflection accelerator tube, which has virtually doubled the length of the time base, the incorporation of the Y-shift control within the instrument, and the development of the instrument for use at 5 Mc/s.

VALVE POSITIONER AND LEAK DETECTOR

An improved valve positioner, and a leak detector designed as a production tool for the detection of minute leaks in castings and other components are two of the instruments to be exhibited by Sunvic Controls Limited, 10, Essex-street, London, W.C.2, together with other items in their "Nullmatic" range. Also to be shown are a "plug-in" controller; a flush-type control station, which incorporates both an indicating pointer and a manually set "memory-pointer" so that deviation of variables can be quickly checked; a miniature pressure regulator; and a number of pressure transmitters. In addition there will be an industrial batch counter and a pulse-height analyser.

The Sunvic valve positioner, which is shown in Fig. 5, has been built to overcome the friction in a diaphragm-motor control valve, and its makers claim that it can detect control-instrument pressure changes of less than 1 in. water gauge. It forces the diaphragm valve to adopt a position corresponding to the instrument control pressure, and provides dependable and precise response to the throttling action of the most sensitive automatic controller.

It has been designed for automatic-control applications that require wide throttling ranges; to give efficient operation with characterised valves; and for installations employing high

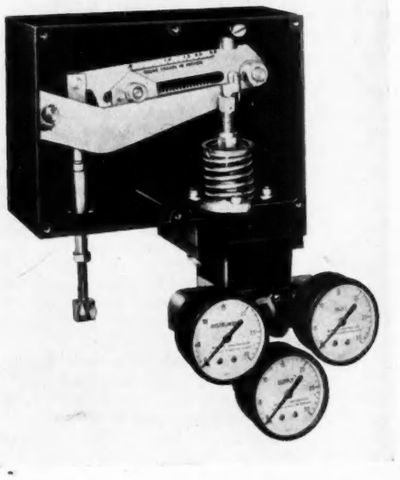

Fig. 5 The Sunvic valve positioner overcomes the friction of a diaphragm-motor control valve and forces it to take up a position corresponding to the instrument control pressure. It is sensitive to pressure changes of less than 1 in. water gauge.

pressures and requiring tight valve-stem packing, or where the pressure drop across the valve is excessive. It is also suitable for use with fluids that gum or choke the valve, viscous fluids, or fluids containing solids in suspension.

The sensitivity of the positioner is such that it will respond to less than 0·2 per cent. of full-scale instrument pressure change, and it is adjustable, by means of a rack and pinion, for valve travel up to 3 in. The capacity of the air pilot permits rapid response, and a full-range change from 3 to 15 lb. per square inch is obtained in approximately 11 seconds on, for example, the average 1-in. stroke valve (150 cubic-inch capacity). Units for various valve strokes and control ranges are made, 3 to 15 lb. per square inch and 5 to 25 lb. per square inch being particular examples, and others extend as low as 2 lb. per square inch and as high as 60 lb. per square inch A by-pass valve can be fitted, which permits the positioner to be removed from the circuit without interrupting the control process.

To be continued

CONTINUOUS SUPERSONIC WIND TUNNEL

1—MAIN INSTALLATION WITH MACH RANGE OF 0·3 TO 3

A 10,000 horse-power continuous supersonic wind tunnel has recently been inaugurated at the Whitley works of Sir W. G. Armstrong Whitworth Aircraft Limited, Coventry. This variable-density tunnel will be capable of testing models 16-in. long in the Mach-number range 0·3 to 3·0, although the tunnel may well be capable of higher Mach numbers. It will be used for investigating rockets, advanced jet engines, guided missiles and future high-speed aircraft. It is of particular interest in that its upper air-speed limit is in the region of the so-called "heat barrier" where the heat generated by motion through the air is sufficient to make present-day engines and airframes unserviceable. A schlieren camera is used for photographing air-flow patterns. Some further information concerning the new wind tunnel appears in a Weekly Survey note in this issue.

CAPABLE OF TWO STARTS EVERY HALF HOUR

The need for supersonic aerodynamic research has become sufficiently great to make a continuous-flow tunnel capable of operating efficiently and economically through a Mach-number range of 0·3 to 3·0 one of the most vital requirements of the aircraft industry. Intermittent tunnels, which are most commonly in use, have had the serious disadvantage of short running times, and this has been a serious check to progress, since thousands of readings are required for the development of aircraft and missiles.

Intermittent tunnels have been preferred, however, because they could be started up in a matter of seconds, and because supersonic flow could be established in the working section with great rapidity. Continuous-flow tunnels built so far have had starting sequences lasting from 15 minutes to two hours. They have also had the disadvantage that it is impossible to build up speed gradually, as the flow tends to jump from subsonic to supersonic discontinuously, thus subjecting the model to abnormally high stresses.

The tunnel built by Sir W. G. Armstrong Whitworth Aircraft, Limited, has overcome both these difficulties; its general layout is shown in Fig. 1. In co-operation with motor and switchgear manufacturers, it has been designed so that the motor starting sequence lasts only one minute. By cooling the liquid starter two starts every half hour can be maintained indefinitely—a performance believed to be unequalled anywhere.

Flow at supersonic speeds must be established past the model as quickly as possible in order to limit the considerable loads imposed during starting and stopping on the strain-gauge "sting," which supports the model (Fig. 2). This is achieved by starting the motor-compressor set, which may be seen in Fig. 3, with the compressor-inlet butterfly valves closed. By means of a switch, oil pressure can be applied suddenly to these valves, causing them to open (or close) in 3½ seconds, and starting and stopping are completed nearly as quickly as with an intermittent tunnel. This switch can be operated as frequently as required, while the compressor continues to run at full speed. A small leakage past the butterfly valves ensures adequate air cooling of the compressors, which are surging during this phase of the operation; however, indefinite surging of the centrifugal compressors does no harm to the compressor set.

It is well known that it is necessary to examine subsonic concepts carefully before applying them in the supersonic field, and this is particularly true of the practice of describing low-speed tunnels by the size of their working sections. Whereas a given size of tunnel is suitable for testing at all speeds within the low-speed range, at supersonic speeds a smaller working section can be permitted at higher speeds. Supersonic tunnel interference vanishes if it is arranged that the reflection of the shock wave from the nose of the model by the tunnel wall just misses the tail of the model, as shown in Fig. 4. This reflected wave is the first signal indicating the presence of the tunnel wall, and if it misses the rear of the model, the tests will simulate motion in an unbounded medium. It is thus necessary to specify both working-section size and Mach number.

There is another major difference between subsonic and supersonic wind tunnels. The air speed in a subsonic tunnel increases as the "blow" produced by the power unit rises, but although this extra blow is also required to give faster supersonic speeds, the size of the working section must be varied at the same time. The supersonic Mach number attained depends only on the ratio of working-section area to throat area, provided that sufficient pressure difference is available to establish supersonic flow. The curve shown in Fig. 5 gives the pressure ratios assumed to be necessary for the tunnel to run at any given Mach number.

Consequently it was decided that a series of fixed working sections machined from cast iron should be employed. Thus, only one wind-tunnel model need be made for a given project, while the set of different working sections would give the various supersonic speeds.

SIZE OF WORKING SECTION AND MACH NUMBER

At the best, these working sections must be of fixed size, with different throat sizes, or conversely; and as the power usage for supersonic tunnels is high, the working-section size was fixed at that just necessary for testing a particular model.

Accordingly a standard model was chosen,

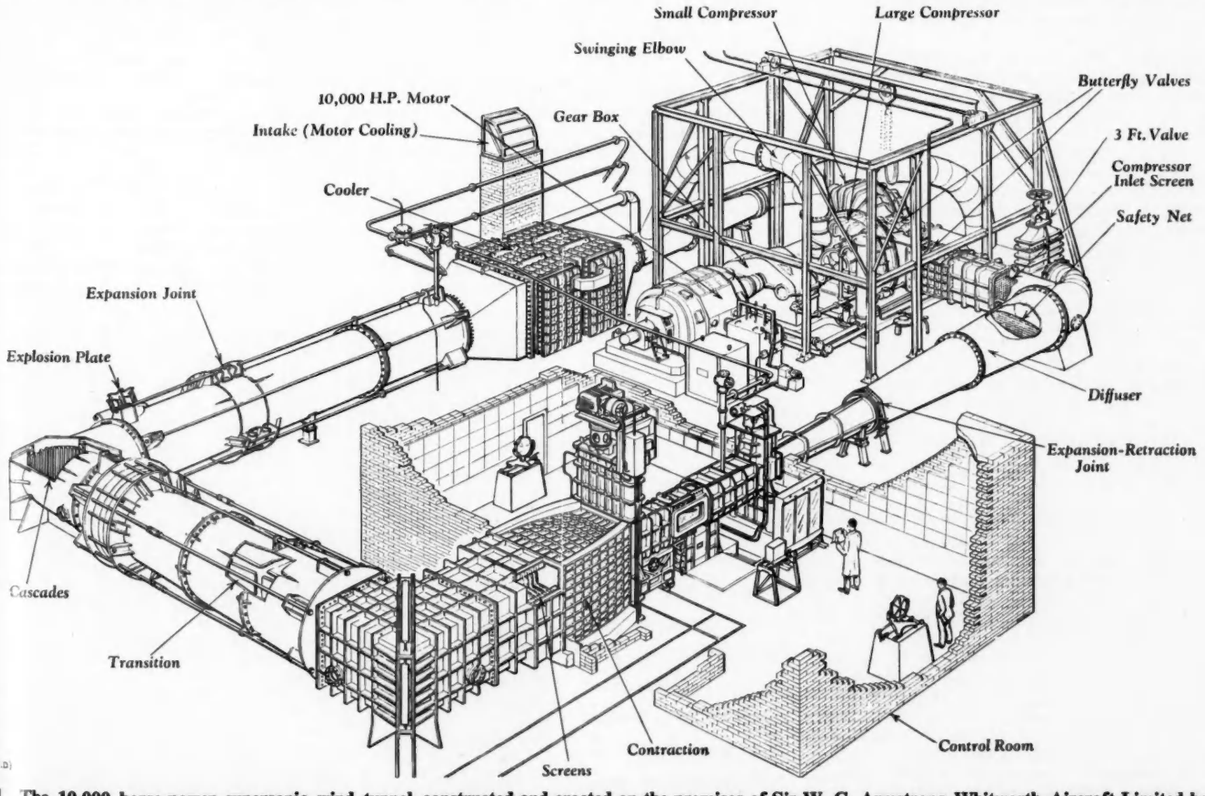

Fig. 1 The 10,000 horse-power supersonic wind tunnel constructed and erected on the premises of Sir W. G. Armstrong Whitworth Aircraft Limited has a Mach-number range of 0·3 to 3·0, is continuous in operation and can be started and stopped almost as quickly as an intermittent tunnel.

Fig. 2 In order to limit the considerable loads imposed during starting and stopping on the strain-gauge " sting," which supports the model and transmits test data, supersonic flow past the model can be established quickly and evenly.

as shown in Fig. 4, with a 10-deg. half-angle cone at the front, a 4-in. span tail at the rear, and an overall length of 16 in. The working-section sizes needed at different Mach numbers from 1·4 to 2·5 were calculated, and were converted into a curve relating pressure ratios and volume flow of air, by means of the graph in Fig. 5. The " minimum air requirement " curve so obtained is shown in Fig. 6.

TWO ALTERNATIVE WORKING SECTIONS

In choosing the air-flow source the best compromise between convenience, simplicity and economy was found to be two centrifugal compressors, working in parallel to supply a 20-in. wide working section at Mach numbers up to 1·8, and working in series to supply a 14½-in. wide working section at Mach numbers above 1·8. The characteristic curves of the Daniel Adamson compressors are shown superimposed in Fig. 6.

The dotted curve shows the wasteful characteristic of a typical axial-flow compressor, which would handle enough air for the M = 1·4 condition, and yet have enough compression ratio to drive at a Mach number of 2·5. An unnecessarily large volume of air would be compressed at the higher Mach numbers, resulting in higher capital and operating costs. A single axial compressor would have permitted a fixed working-section size, with only the throat size varying with Mach number, but this proved to be an uneconomical approach.

VARIABLE BALANCE SECTION

To obtain the necessary variation with Mach number, a balance section with hinged liners was introduced between the working section and the diffuser, and by standardising the 20-in. (parallel) and 14½-in. (series) widths of working section, it proved reasonably simple to design and manufacture these liners. Similarly, two alternative " adaptors " blend the vertical walls of the contraction smoothly into the two different widths, and at the same time the horizontal walls into the nozzle profiles. The arrangement of the working section is shown in Fig. 7. As the nozzles have to be specially designed and manufactured for each Mach number, there is every reason to make the height of the section as great as possible, based on the compressor characteristic curves of Fig. 6. The sizes and Mach numbers adopted are given in the accompanying table.

TABLE.—WORKING SECTION SIZES.

Mach number	Width (inches)	Height (inches)	Assumed Pressure ratio	Starting Pressure ratio (cold)
0·3 to 1·2 (transonic)	20·0	22·0	1·32 at M = 1	—
1·25	20·0	24·0	1·45	—
1·4	20·0	24·0	1·55	—
1·55	20·0	20·0	1·75	—
1·7	20·0	19·0	1·94	—
1·9	14·5	19·0	2·22	—
2·1	14·5	19·0	2·50	2·52
2·3	14·5	19·0	2·80	2·90
2·5	14·5	19·0	3·13	3·28
3·0	14·5	16·0	3·93	4·35

ISOLATION OF THE WORKING SECTION

The tunnel circuit is filled with dry air, usually not at atmospheric pressure; and a dewpoint below −25 deg. C. has already been maintained. This demands an initial drying period of at least an hour, and it is essential to preserve this dryness during model changes, if delays are to be avoided. Sluice valves shown at each end of the working section in Fig. 1 cut off the working section at the end of each run, taking 1½ minutes to close or open. Only the working section is then exposed to atmosphere; the window is swung open, the model adjusted, the window again closed, wet air sucked out, and the sluice valves re-opened. The whole sequence from supersonic running back again to supersonic running can be completed in 5 to 10 minutes, without great demands on the air drying and compressing plant, since the air pressure of the main tunnel volume is not affected.

It has been found that the disadvantages inherent in continuous tunnels have been minimised by this rapid stop and start equipment, and that a large number of useful readings can be taken per hour, whether the test involves short or long runs.

TUNNEL SHELL

As may be seen in Fig. 1, the tunnel shell is of orthodox fabricated welded steel construction made in sections and bolted together with inset rubber joints. The cooler, elbows, contraction, and the large end of the diffuser are rigidly fixed into reinforced-concrete foundations, while the remaining sections are supported on rollers. Two bellows-type steel expansion joints are installed, with the end loads and over-turning moments reduced by the use of six longitudinal tie rods. An explosion plate is also incorporated in the shell, so that excess pressure will shear the pin which holds it in place.

The shell is 6 ft. in diameter from the air-cooler outlet to the first elbow, which contains an elliptical cascade to turn the air through a right angle. This elbow is then connected to a square-section elbow by means of a transition enclosed in a cylindrical shell. This construction avoids the use of thick flat plates, and the cavities so formed are vented to allow the pressure on the inner plates to equalise. The square elbow also contains a rectangular cascade to turn the air again through a right angle into the screen section, in which are fitted four fine-mesh domed screens mounted in wooden frames spaced 6 in. apart. These screens are removable through a special access door. The screen section is attached to the contraction, which is made from four cast-iron ribbed plates suitably profiled and bolted together. This contraction, in turn, supports the large valve, which is bolted to its downstream end. The diffuser tapers from 1 ft. 10½ in. by 2 ft. 6 in., to 6 ft. 2 in. in diameter, where it branches into the two compressor inlets. A safety net is provided at the end of the diffuser at an angle of 45 deg. to the axis, and a ½-in. mesh screen is provided at each compressor inlet to protect the rotors, should a model break up or become detached from its mounting.

Thermal expansion in the diffuser is compensated by a specially designed expansion-retracton joint shown in the centre spread, which can also be compressed by hand-operated screw jacks to create a gap at either end of the working section, following the removal of the quick-release

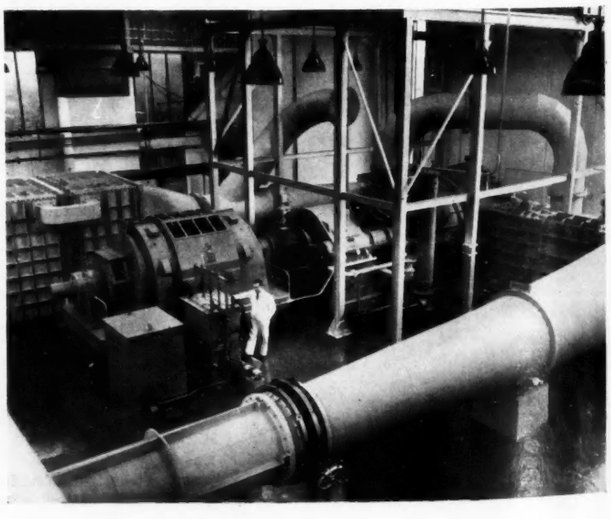

Fig. 3 Large compressor, small compressor, swinging elbow, 10,000 horse-power motor and, in the foreground, the diffuser. The swinging elbow permits change-over from parallel to series compressor operation at M = 1·8.

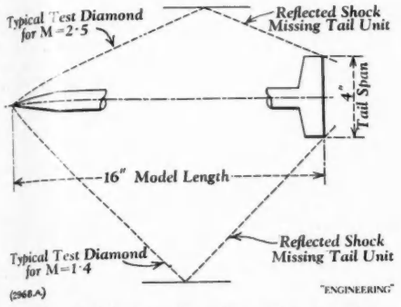

Fig. 4 Model dimensions for which tunnel was designed. If the shock wave from the model nose is reflected by the tunnel wall so that it misses the model tail, then motion in an unbounded medium is simulated.

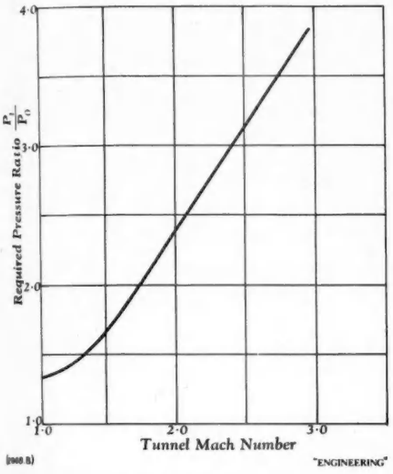

Fig. 5 Curve showing pressure ratio plotted against M. For the tunnel to run at a given Mach number, a corresponding pressure difference is necessary.

bolts. Bellows-type copper expansion joints are provided before the small-compressor inlet and at both compressor outlets, one being attached to the swinging elbow. The ducting from the small-compressor outlet to the air-cooler inlet tapers from 2 ft. 6 in. to 4 ft. in diameter, and the ducting from the large-compressor outlet to this or to the small compressor inlet is 3 ft. in diameter; the large-compressor inlet is 2 ft. 3½ in. by 4 ft. 11 in. The cooler has a cross section of 8 ft. by 8 ft. 3 in. and contains 6,380 ¾-in. diameter tubes, giving a cooling surface of 10,400 sq. ft. It passes 1,750 gallons of water per minute.

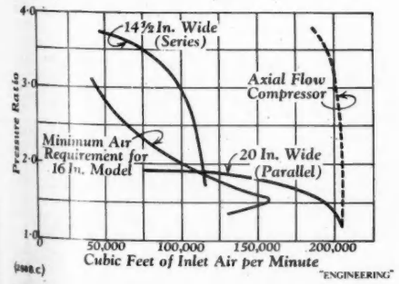

Fig. 6 Comparison of tunnel air requirement with air supplied by compressors. It is clear that the two centrifugal compressors are more economical than an axial-flow compressor, which would provide an unnecessarily large volume of air at higher Mach numbers.

SERIES PARALLEL OPERATION OF TWO COMPRESSORS

The changeover from series to parallel operation of the compressors at M = 1·8 involves the swinging of a large pipe elbow, and the operation of a 3-ft. valve. These are shown on the centre spread in Fig. 1. It is also necessary to change the small side plates of the balance section to cater for the appropriate working-section width. This has been done in between 4 and 6 hours. Working-section changes can, however, be performed in less than an hour without disturbing the model. The whole plant is interlocked to prevent starting or running in the absence of cooling water, oil pressure, or with any valves in the wrong positions.

A window in the wall of the control room permits the operator to see the compressor set at all times, and both operator and scientific observer can view the model, more especially during the critical starting and stopping periods. Although a duplicate maximum-demand meter is installed on the control panel, the present contract with the East Midlands Electricity Board for electricity does not take maximum-demand into account, and, in return, the tunnel will not be run during morning and evening peak periods in the four winter months.

"THERMAL-BARRIER" TESTING

It will be appreciated that the initial tunnel design had to be based on performance estimate but now that it is complete the actual performance can be substituted for the design data. In particular it was found (see Fig. 8), that the main compressors give a higher maximum pressure ratio than was forecast, both in series and in parallel. This has enabled the 19-in. by 14·5-in. working section to be run with the compressors in parallel as well as in series, which will be valuable in minimising changeover from series to parallel compressor operation.

The higher pressure ratio in series, which in round figures is 4 : 1 actual, as against 3½ : 1 design, will increase the top speed of the tunnel from M = 2·5 to M = 3. In this connection it has been found that a pressure ratio of 4·5 : 1 is available when starting from cold, and this gradually drops back to 4 : 1 as the compressors warm up in the first half hour of running. This extra temporary pressure ratio is most useful, as a working section requires more pressure to establish supersonic flow than to maintain it, particularly at Mach numbers above 2·5 or 3. From Fig. 8 it will be seen that this is precisely where the extra initial driving pressure is available.

The efficiency of the compressor set is not as high as had been expected, and this fact coupled with the extra pressure ratio has decreased the air density corresponding to maximum motor power. Thus the Reynolds number available will be somewhat less than expected, and a curve of maximum available Reynolds number at various Mach numbers is shown in Fig. 9.

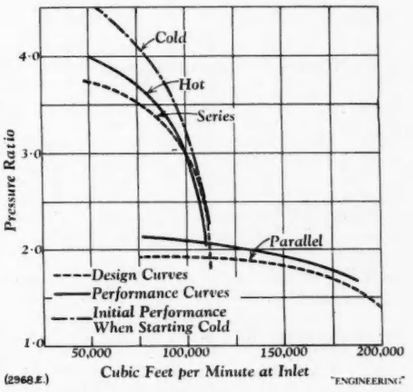

Fig. 8 Compressor characteristics, showing the difference between design rating and actual performance. The increased pressure ratio available on starting is beneficial, since more pressure is required to establish supersonic flow than to maintain it.

It is a distinct advantage to have the extra Mach-number range as the country is critically short of large supersonic tunnels capable of a Mach number of 3. It was anticipated in designing the tunnel that the "thermal barrier" would limit aircraft design speeds to about M = 3 for some time to come.

PERFORMANCE

The performance of the tunnel and other details may be summarised as follows:

Mach Number Range.—0·3 to 3·0.

Pressure Range.—Stagnation pressure from 0·2 atmospheres to 1·5 atmospheres absolute, and in certain cases to 2·8 atmospheres absolute

Reynolds Number Range.—From 1×10^6 to 6×10^6 per foot of model length at all Mach numbers above 1·6, and up to 10×10^6 in certain cases.

Incidence Range.—From − 6 deg. to + 45 deg. at all speeds.

Rolling-Angle Range.—From 0 deg. to 200 deg. at all speeds.

Longitudinal Model Position.—Model may be

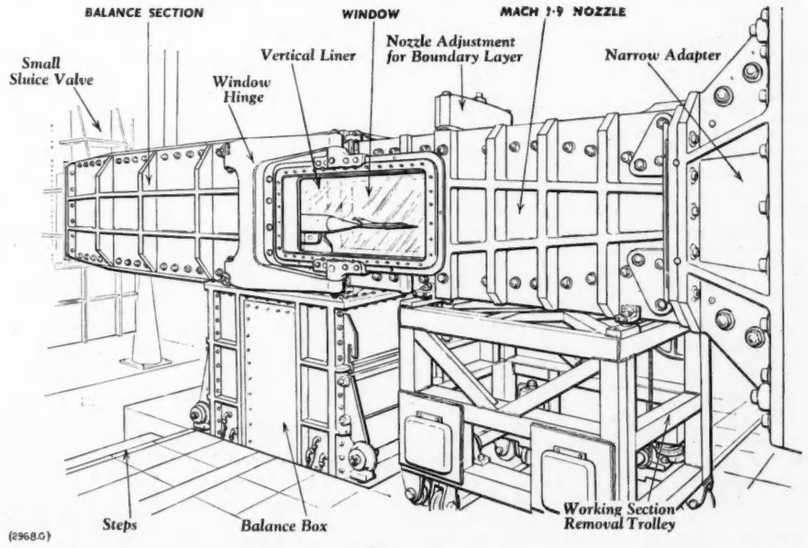

Fig. 7 Working section of tunnel. To provide the necessary variation in working-section size with different Mach numbers, a balance section with hinged liners is incorporated.

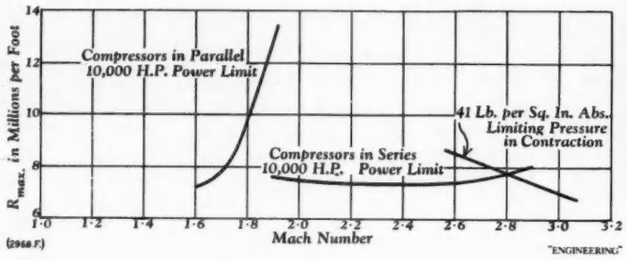

Fig. 9 Maximum attainable Reynolds number in terms of Mach number predicted from compressor performance curves. The high Mach numbers obtained in the tunnel make it suitable for testing aircraft models and engines in the "thermal barrier" range.

placed anywhere in the vertical plane of symmetry, but no lateral shift is provided.

Motor Rating.—7,700 h.p. continuous and up to two hours overload at 10,000 h.p.

Quantity of Air Compressed.—1·6 tons per minute at atmospheric stagnation pressure and M = 1·9.

Volume Flow.—5,900 to 200,000 cub. ft. per minute (see Fig. 6).

Cost of Air Compressed.—Eleven pence for each ton of air moving past the model at M = 1·9. Full power costs for electricity amount to approximately £30 per hour for electricity alone.

(*A subsequent article will give further details of the installation, its construction and various items of ancillary plant.*)

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ELECTRICALLY OPERATED DIAPHRAGM VALVE

The Saunders Valve Company, Limited, Grange-road, Cwmbran, Newport, Monmouthshire, have produced a range of diaphragm valves with electrical actuators. The 8-in. size was exhibited at the recent British Industries Fair. In each case the actuator is a Rotork 100A unit fitted with a 2-h.p. motor, and the five valves range in size from 6 in. to 12 in. with corresponding line pressures from 100 to 25 lb. per square inch.

The unit is arranged for operation with contactor-type control gear and can be supplied for local and remote control. The fully open and closed positions of the valve are controlled by limit micro-switches fitted on the actuator unit. If required, remote control panels can be fitted with indicator lights, or with a dial indicator giving the actual position of the valve. The indicators are normally arranged for working with separate micro-switches on a 230-volt single-phase circuit. A mechanical indicator of valve position is fitted to the actuator.

The actuator unit has the motor drive connected to the valve spindle through a worm and crown wheel. The drive is reversible at any position between open and closed, and is normally arranged so that when changing valve direction there is a short delay between the motor starting and the valve commencing to move. Quick valve response in both directions can, however, be arranged.

The open position of the valve is controlled by a micro-switch which operates when a fixed position has been reached. The micro-switch controlling the closed position is operated by the torque effort of the drive mechanism, which is adjusted to the value required for closure against maximum line pressure. With this feature, an obstruction in the valve preventing full closure causes the torque of the drive mechanism to reach the limiting value and the motor to be switched off, thus preventing damage to the motor and other electrical gear from the retention of the motor in a "stalled" position.

A handwheel is provided for emergency operation and is interlocked with the micro-switches to prevent the motor being switched on while the handwheel is being used. A dog-clutch disengages the handwheel from the drive mechanism during normal electrical operation and a locking device is provided to prevent engagement while the motor is running. The drive gearbox is oil lubricated, and the valve is designed for mounting with the spindle in the vertical position.

LAUNCHES AND TRIAL TRIPS

S.S. "DIAMANTIS PATERAS."—Single-screw cargo vessel, built and engined by John Readhead and Sons, Ltd., South Shields, for Diamante Sociedad de Transportes S.A., Piræus (Agents: Diamantis Pateras, Ltd., London, E.C.3.) Main dimensions: 430 ft. between perpendiculars by 59 ft. by 38 ft. 6 in. to upper deck; deadweight capacity, about 10,100 tons on a draught of 26 ft. 1 in. Triple-expansion steam reciprocating engine, working in conjunction with a Bauer-Wach low-pressure exhaust turbine. Steam supplied by three oil-fired boilers. Service speed 12 to 12½ knots. Trial trip, May 5.

M.S. "SIMBA."—Single-screw cargo vessel, with accommodation for a small number of passengers, built and engined by Burmeister and Wain, Ltd., Copenhagen, Denmark, for the East Asiatic Co., Copenhagen, Denmark. Main dimensions: 452 ft. 9 in. by 62 ft. 6 in. by 29 ft. 9 in. to second deck; deadweight capacity, about 9,944 tons on a draught of 27 ft. 3 in. B. and W. seven-cylinder single-acting two-stroke Diesel engine, developing 9,800 i.h.p. at 115 r.p.m., arranged for burning Diesel oil or boiler fuel. Speed, 16·8 knots. Launch, May 10.

S.S. "MASTER GEORGE."—Single-screw cargo vessel, built and engined by John Readhead and Sons, Ltd., South Shields, for Mr. N. G. Nicolaou, Monte Carlo. (Agents: George Nicolaou, Ltd., London, E.C.3.) Main dimensions: 441 ft. 3 in. between perpendiculars by 61 ft. by 39 ft. 3 in. to upper deck; deadweight capacity, about 11,500 tons on a draught of 28 ft. Triple-expansion steam reciprocating engine, working in conjunction with a Bauer-Wach low-pressure exhaust turbine. Steam supplied by three oil-fired boilers. Service speed, 13 knots. Launch, May 23.

S.S. "HEMIPLECTA."—Single-screw oil tanker, built and engined by Cammell Laird & Co., Ltd., Birkenhead, for Shell Tankers, Ltd., London. Main dimensions: 530 ft. by 69 ft. 3 in. by 39 ft.; deadweight capacity, about 18,000 tons on a draught of 29 ft. 9in. Geared steam turbines developing 8,250 s.h.p. Launch, May 23.

H.M.S. "TIDE AUSTRAL."—Fast-replenishment oil tanker, built and engined by Harland and Wolff, Ltd., Belfast, to the order of the Admiralty, London, S.W.1, for the Royal Australian Navy. First of new class of vessel constructed for supplying fuel to warships. Main particulars: length, 550 ft. between perpendiculars; beam, 71 ft.; deadweight capacity, about 17,700 tons. Delivered, May 28.

M.S. "LEEDS CITY."—Single-screw cargo vessel, built and engined by William Doxford and Sons, Ltd., Sunderland, for Sir William Reardon Smith and Sons, Ltd., Cardiff. Second vessel of a series of four for these owners. Main dimensions: 436 ft. 6 in. between perpendiculars by 59 ft. 2¼ in. by 28 ft. 8 in.; deadweight capacity, about 9,300 tons on a draught of 25 ft. 5½ in. Doxford four-cylinder opposed-piston oil engine, developing 4,400 b.h.p. at 100 r.p.m. Speed in service, 13¾ knots. Delivered, June 1.

S.S. "BARON GLENCONNER."—Single-screw cargo vessel, built by the Caledon Shipbuilding and Engineering Co., Ltd., Dundee, for H. Hogarth and Sons, Ltd., Glasgow. Main dimensions: 430 ft. between perpendiculars by 58 ft. by 37 ft. 6 in. to shelter deck; deadweight capacity, about 9,300 tons on a draught of 25 ft. 3 in.; gross tonnage, about 5,000. Steam reciprocating engine, working in conjunction with a Bauer-Wach exhaust turbine and developing 3,350 i.h.p., constructed by John G. Kincaid & Co., Ltd., Greenock. Steam supplied by three oil-fired boilers. Speed 12½ knots. Launch, June 3.

M.S. "SIR WILLIAM HARDY."—Single-screw fishing-research trawler, built by Hall, Russell & Co., Ltd., Aberdeen, to the order of the Director of Navy Contracts, Admiralty, London, S.W.1, on behalf of the Department of Scientific and Industrial Research, for assisting in research work on the preservation of fish as food, carried on by the Torry Research Station, Aberdeen. Stated to be the first Diesel-electric trawler to be built in this country. Main dimensions: 131 ft. between perpendiculars by 27 ft. 6 in. by 15 ft. Power for main propulsion, trawl winch and auxiliary purposes supplied by six Diesel-driven generating sets, supplied by the Metropolitan-Vickers Electrical Co., Ltd., Manchester 17, and installed by the shipbuilders. Propulsion motors have a maximum continuous output of 600 s.h.p. at 200 r.p.m. Fishing trials completed, June 6.

M.S. "NORMAN PRINCE."—Single-screw cargo vessel, with accommodation for twelve passengers, built by the Burntisland Shipbuilding Co., Ltd., Burntisland, Fife, for the Prince Line Ltd. (Managers: Furness Lines), London, E.C.3. Designed for the carriage of citrus fruits and general cargoes between ports on the Mediterranean and in the United Kingdom. Seventh vessel built in recent years for these owners. Main dimensions: 313 ft. between perpendiculars by 46 ft. 3 in. by 27 ft. 9 in. to shelter deck; deadweight capacity, 3,500 tons. Ailsa-Doxford three-cylinder opposed-piston Diesel engine, developing 2,300 b.h.p. in service, constructed by the Ailsa Shipbuilding Co. Ltd., Troon. Engine designed to operate on heavy oil. Launch, June 6.

M.S. "LA ORILLA."—Single-screw cargo vessel, built by Bartram and Sons, Ltd., Sunderland, for Buries Markes, Ltd., London, E.C.3. Main dimensions: 445 ft. between perpendiculars by 62 ft. by 40 ft. 2 in. to shelter deck; deadweight capacity, about 10,850 tons on a draught of 26 ft. 11¾ in. Kincaid-Harland and Wolff-Burmeister and Wain single-acting two-stroke opposed-piston Diesel engine, constructed by John G. Kincaid & Co., Ltd., Greenock. Engine developing 4,400 b.h.p. at 115 r.p.m. in service and designed to operate on heavy oil. Speed, 13 knots. Launch, June 6.

M.S. "WOOLWICH."—Single-screw cargo vessel, built by the Caledon Shipbuilding and Engineering Co., Ltd., Dundee, for the Britain Steamship Co., Ltd. (Managers: Watts, Watts & Co., Ltd.), London, E.C.2. Main dimensions: 465 ft. overall by 58 ft. 6 in. by 38 ft. to shelter deck; deadweight capacity, about 10,000 tons on a draught of 27 ft. Stephen-Doxford four-cylinder opposed-piston oil engine, constructed by Alexander Stephen and Sons, Ltd., Glasgow. Trial trip, June 6.

S.S. "REINA DEL MAR."—Twin-screw passenger and cargo vessel, built by Harland and Wolff, Ltd., Belfast, for the Pacific Steam Navigation Co., Liverpool, for service between the United Kingdom, France and Spain and Central and South America. Accommodation provided for 201 first-class, 218 cabin-class and 343 tourist passengers. Main dimensions: 560 ft. between perpendiculars by 78 ft. by 44 ft. to "C" deck; gross tonnage, 19,350. Two-shaft arrangement of Parsons double-reduction geared steam turbines, developing a total of 17,000 s.h.p. at 112 r.p.m. in service. Steam supplied by two Babcock and Wilcox water-tube boilers. Launch, June 7.

M.S. "P.8."—Off-shore patrol vessel, built and engined by the Chantiers et Ateliers Augustin Normand, le Havre, for the French navy. Main dimensions: 173 ft. 8½ in. in length by 22 ft. 10⅛ in. in breadth; mean draught 6 ft. 8 in.; displacement, 380 tons. Four Diesel engines, coupled to two shafts and together developing 3,500 h.p. Speed, 18·7 knots. Launch, June 7.

S.S. "NAREK."—Single-screw oil tanker, with accommodation for a small number of passengers, built by the Blythswood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for the Baltic Trading Co., Ltd., London, E.C.2. Main dimensions: 552 ft. between perpendiculars by 75 ft. by 40 ft.; deadweight capacity, about 20,000 tons. Parsons double-reduction geared steam turbines, developing 8,700 s.h.p. at 100 r.p.m., constructed by David Rowan & Co., Ltd., Glasgow. Steam supplied by two Foster Wheeler oil-fired water-tube boilers. Launch, June 8.

M.S. "PINEMORE."—Single-screw cargo vessel, with accommodation for twelve passengers, built by the Burntisland Shipbuilding Co., Ltd., Burntisland, Fife, for the Johnston Warren Lines, Ltd., Liverpool (Managers: Furness, Withy & Co., Ltd., London, E.C.3). Vessel designed for the carriage of citrus fruits and general cargo between East Mediterranean ports and the United Kingdom. Main dimensions: 345 ft. between perpendiculars by 52 ft. 7 in. by 32 ft. 4 in. to shelter deck; deadweight capacity, 4,900 tons on a draught of 21 ft. 9⅛ in. Hawthorn-Doxford four-cylinder opposed-piston Diesel engine, developing 3,300 b.h.p., constructed by Hawthorn Leslie (Engineers) Ltd., Newcastle-upon-Tyne, and installed by the shipbuilders. Engine arranged to burn heavy-fuel oil when required. Trial trip, June 9.

FRENCH AIRCRAFT DEVELOPMENTS

TRANSPORT AIRCRAFT AND HELICOPTERS

Continued from page 773

In last week's issue of ENGINEERING, we described the developments in French light jet-propelled aircraft that have taken place during the last two years. This week we propose to deal with transport aircraft and helicopters.

CARAVELLE JET AIR-LINER

The principal " news " at the 1955 Salon was the Caravelle twin-jet medium-range airliner, the first to be designed and constructed in France; a prototype version is shown in Fig. 4. The first flight of the Caravelle took place, as planned, two weeks before the opening of the Salon, on May 27, and up to the time of the opening she had completed 7½ hours flying. Designed by Société Nationale de Constructions Aéronautiques du Sud-Est, 6 Avenue Marceau, Paris (8), to a specification issued in 1952, by the Secrétariat Général à l'Aviation Civile et Commerciale, the Caravelle was intended mainly to serve the French North African routes which are largely concerned with mixed traffic, passengers and freight. Two prototypes are on order, construction of the second being well advanced.

The prototype Caravelle, which is designed to carry 70 first-class passengers, is powered by two 10,000-lb. thrust Avon jet engines constructed under licence by the Hispano Suiza company. The interesting point about the engines is their location at the rear end of the fuselage; this has a number of advantages. It has now become common knowledge that when jet engines are mounted in the wings, the jet efflux is likely to give rise to high-frequency vibrations in the rear of the fuselage which can lead to local fatigue cracks. With the engines at the tail end, these effects are eliminated, and clearly the tail surfaces are also free from any jet-buffeting effects. The thrust line is arranged to pass close to the aircraft centre of gravity, so that unpleasant trim changes should not arise when thrust is increased or decreased.

The tail-end engine location appears to be the ideal for minimising cabin noise, and the external pods facilitate engine changes and servicing. The removal of the engines from the wings results in a wing configuration as clean as that of a single-engine fighter, and allows the use of a continuous unbroken run of landing flap.

The manufacturers claim that, since all fuel is carried in the wings and is therefore separated from the engines, the possibility of fire in the aircraft is lessened. In order to get the fuel from the wings to the engines it has, of course, to pass through pipelines within the fuselage. These pipelines, about 32 ft. long, are enclosed in sealed stainless-steel ducts.

Dimensions and performance.—The Caravelle has a span of 112 ft. 6·4 in., an overall length of 103 ft. 4 in., and a height of 28 ft. 6·1 in. The wing area is 1,579 sq. ft., the aspect ratio 8·02 and the sweepback on the quarter-chord line is 20 deg. The aerofoil section is NACA 651 212, the dihedral is 3 deg. and there is a washout of 2 deg. 11 min. The integral wing fuel tanks have a total capacity of 3,960 Imperial gallons. No fuel is carried in the fuselage.

The cabin has a floor area of 430·5 sq. ft. and a total volume of 2,543 cub. ft. There are four cargo holds—two in the cabin, fore and aft, with a volume of 600 cub. ft. in all, and two below the cabin floor with a total volume of 434 cub. ft. The floor is stressed to take a loading of 123 lb. per square foot. The bulkhead between the passenger cabin and the upper forward cargo hold can easily be shifted as required and the seats and luggage racks in the forward part of the aircraft can be folded up against the cabin walls to give additional cargo space. By this means it is possible to increase the total space available for cargo to 1,491 cub. ft. and still carry 40 passengers. With all the seats and racks folded, a usable cargo volume of 2,090 cub. ft. is available.

The passenger entry door is under the tail outside the pressure cabin, and reached by a retractable stairway integral with the ventral door, which is hydraulically operated. Freight is loaded into the forward part of the fuselage through a 6 ft. 6 in. by 5 ft. 11 in. freight door, also hydraulically operated.

As already recorded, the prototype Caravelles are powered by 10,000-lb. thrust Avon RA 26 engines. The production machines, however, are expected to be powered by Avon RA 29 engines developing 11,000 lb. static thrust and the following estimated performance figures, in standard atmosphere, are based on the higher thrust. The weight of the aircraft empty is 46,300 lb.; the zero fuel weight is 68,300 lb., and the maximum take-off weight, based on performance considerations is 89,700 lb. Structurally, the Caravelle is designed to a maximum weight of 90,400 lb. for take off and 79,400 lb. for landing.

At 89,700 lb., the aircraft requires a take-off distance of 5,450 ft. with one engine out of action at the critical speed. With both engines operating, the Caravelle will take off in 4,300 ft. A landing distance, at maximum weight, of 3,770 ft. is required. The maximum cruising speed is 490 m.p.h. and the cruising altitude between 34,500 ft. and 39,300 ft. Allowing fuel reserves for a diversion of 160 nautical miles, half-an-hour awaiting permission to land, plus 12 per cent. of the total fuel consumption, the payload/range characteristics are as follows: with 20,900 lb. payload, range 1,320 statute miles; with 15,400 lb. payload, range 1,900 statute miles; with 11,700 lb. payload and full fuel tanks, maximum range 2,330 miles.

Equipment and services.—So far as possible, the instruments and equipment installed in the Caravelle are all well-tried units familiar to civil air-line operators. The cabin of the Caravelle is air-conditioned and pressurised by air bled from the engine compressors, which also provide a hot-air supply for de-icing wings and tail surfaces. The flying controls are power operated.

The landing flaps are of the slotted type and, in the prototype, dropping leading edge flaps can be lowered to improve the low-speed handling characteristics. In the second prototype these flaps will be replaced by a permanent leading-edge " droop." The undercarriage, designed by the Hispano-Suiza company, comprises four-wheel bogie main units and a twin-wheel steerable nose unit. A tail parachute is provided to assist deceleration after landing.

Structure.—The wing, which is joined on the centre-line of the aircraft, has a torsion-box structure with three span-wise webs and a stiffened thick skin. The torsion box forms integral fuel tanks divided into four compartments, fuel being fed from each wing tank to the engine on the same side by two booster pumps. The fuselage is of semi-monocoque construction, in which the longitudinal stringers are attached to pre-formed skin panels by synthetic-resin adhesive and spot welding. The rear part of the fuselage has been specially designed to allow the installation of larger and heavier engines as required during the natural course of development.

With regard to fatigue testing, up to now rigorous repeated pressure tests have been carried out on representative fuselage sections, with very comprehensive strain-gauging, and great care has been devoted in design to minimising stress concentration. The windows are of an unusual rounded triangular shape with well-radiused corners, and the structure is reinforced strongly in the vicinity of the window frames. We understand that, in the light of Comet experience, one of the prototype Cara-

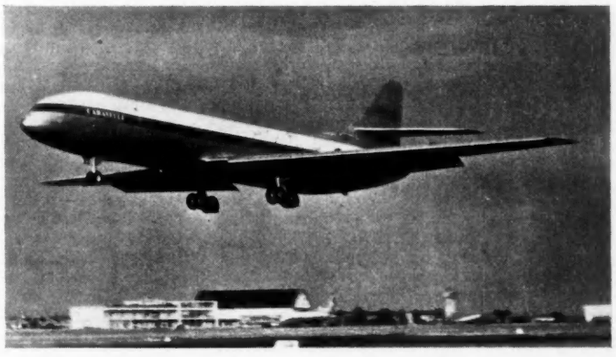


Fig. 4 The Caravelle air-liner, France's first jet liner, which has two jet engines mounted at the rear of the fuselage, can carry a payload of 20,900 lb. over a range of 1,320 statute miles. The maximum cruising speed is 490 m.p.h.

Fig. 5 The high-aspect-ratio HD32 air-liner—France's " D.C. 3 replacement "—has been ordered by Air France and can carry 44 passengers or 13,000 lb. of freight.

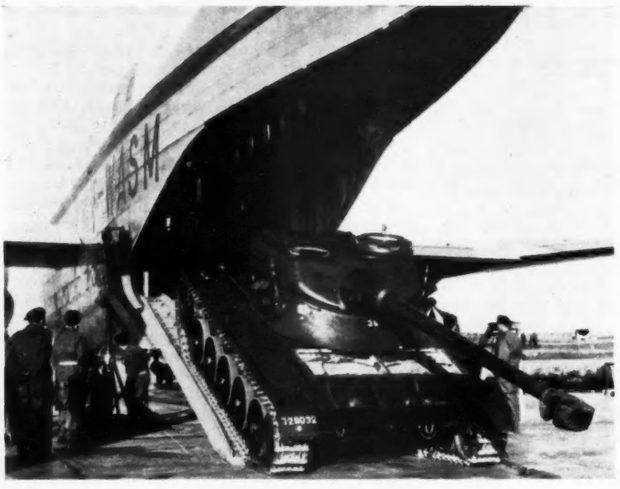


Fig. 6 The military version of the Breguet Deux Ponts has a maximum useful load of 38,000 lb. which can be carried over 750 miles. Load-dropping trials have included the parachuting of a single 6½-ton load.

Fig. 7. The SNCASE Alouette II helicopter powered by an Artouste turbine, has recently surpassed the altitude record for helicopters by attaining a height of 27,100 ft.

velles will most probably undergo a repeated wing-and-pressure loading test in a water tank.

THE HUREL-DUBOIS HD32 AIR-LINER

Earlier this year the HD31 high-aspect ratio twin-engine air liner designed and constructed by Société de Construction des Avions Hurel-Dubois, Route de Verrières, Meudon-Villacoublay, made a successful 12,500-mile tour over Africa. This aircraft, it may be recalled, appeared at the 1953 Salon and was described in the July 17, 1953, issue of ENGINEERING. A later version, the HD32-01, powered by two 1,200-h.p. Pratt and Whitney R-1830-92 engines in place of the 800-h.p. Wright engines of the HD3, made its first flight in December, 1953, and a second machine the HD32-02, representative of the production aeroplane, flew in February this year. All these aircraft were scheduled to appear in the flying display on the last two days.

The HD32 (Fig. 5), can carry 44 passengers, 13,000 lb. of freight, or a mixed load, and is proposed as a DC3 replacement. It is particularly suitable for the smaller operator with limited maintenance facilities and for use in countries where the airfields are not highly developed. The ultra-high-aspect ratio braced wing configuration developed by M. Hurel results in a substantial reduction in induced drag and, in consequence, both take-off and economical cruising performance are considerably improved in comparison with a conventional cantilever monoplane. The Hurel-Dubois company consider that, for short and medium stages, where quite a large proportion of the overall journey time is spent on the ground, a high cruising speed is uneconomic. The HD32 is, in fact, designed to cruise at 168 m.p.h. They have therefore adopted a fixed tricycle undercarriage. This, together with the fact that the cabin is not pressurised and that the Pratt and Whitney engines are thoroughly developed and familiar to flight mechanics, all over the world, makes for economical maintenance.

Air France has placed an order for 24 of these aircraft. Twelve are to be powered with the 1,200-h.p. Pratt and Whitney engines, and 12 with 1,525-h.p. Wright C9HE1 engines. The French Navy has ordered more than 100 machines derived from the HD32, which will be known as the HD35, for anti-submarine search-and-strike duties, to be powered by the more powerful Wright engines. An important point in the design of the HD32 is that the Wright engines can be substituted for the Pratt and Whitney engines without any structural modification.

The Hurel-Dubois company are also entering into an agreement with the British firm F. G. Miles, Limited, Shoreham, Sussex, to form a new British company for the purpose of exploiting the high-aspect-ratio wing. It is proposed to equip a Miles Aerovan freighter with the Hurel high-aspect-ratio wing, and a model of this aircraft was on view on the Hurel-Dubois stand. Maintaining the same payload and range, the new wing is expected to give greatly superior take-off climb and single-engine performance, as well as a higher cruising speed and economy.

DOUBLE-DECK MILITARY TRANSPORT

Société Anonyme des Ateliers d'Aviation Louis Breguet, 24 Rue Georges Bizet, Paris (16), showed a military adaptation (Fig. 6) of the Deux Ponts (double-deck) transport aeroplane (Air France, it may be recalled, are using 12 civil Deux Ponts mixed-cargo aircraft, which they call the Provence, on their North African services; from the passenger's viewpoint, they compare very favourably with most aircraft operating in Europe). The military Deux Ponts has successfully carried out parachute load-dropping trials on a large scale. A total load of 32 tons, comprising two jeeps and a 105-mm. cannon on the lower deck and nine 1-ton cases on the upper deck, was released in 18 seconds. A single 6½-ton load has also been dropped successfully, and the company consider that still larger loads—for instance, an 8-ton bulldozer—could be satisfactorily released. With the floor between decks removed, a 14-ton wagon has been carried in flight.

The maximum permissible payload of the military Deux Ponts, which has an all-up weight of 113,800 lb., is 38,000 lb., which can be carried over a still-air range of 750 miles. With a payload of 33,000 lb., a range of 1,240 miles is possible. Typical military loads might consist of 164 troops plus 4 tons of armament, ammunition or equipment; or one G.M.C. lorry plus three Dodge trucks plus 2·2 tons of fuel; or six 105-mm. cannon plus 4·2 tons of fuel; or eight V.L.R. Delahaye jeeps plus 2·8 tons of fuel.

If orders are placed for Deux Ponts military transport aircraft, the Breguet company propose to substitute slightly more powerful engines, the 2,500-h.p. Pratt and Whitney R-2800 CB17, in place of the present 2,400-h.p. P. and W. R-2800 CA18 engines. The all-up weight would be increased to 119,000 lb. and low-pressure tyres fitted for landing on unpaved air-fields.

BREGUET INTEGRAL TRANSPORT

On their stand the Breguet company also showed several interesting projects in the form of models. The Breguet 940 Integral "convertible" aircraft is their solution to the problem of eliminating lengthy runways. The truly vertical take-off, they contend, imposes severe limitations on the versatility of the aircraft, and is generally unnecessary. What is required is a take-off distance of less than, say, 100 metres. Breguet propose to achieve this by utilising fully the slipstream of the propellers to increase the effective lift, in conjunction with triple-slotted flaps extending over 40 per cent. of the chord and deflecting through nearly 90 deg. In effect, they are using a form of boundary-layer control.

The model on view was actually the 941 military freight project, with four Turboméca free turbines. The propeller discs cover the whole wing span. This aircraft is designed to carry a payload of 3 tons over a distance of 620 miles, with a take-off run of only 60 metres and an initial climb angle of the order of 45 deg. This aircraft is as yet only in project, but a smaller Integral has been ordered by the French air ministry and will probably fly during the course of next year. This machine, for communications duties, will have an all-up weight of about 14,300 lb. and will be powered by four 400-h.p. Turboméca Turmo free turbines.

ALOUETTE II HELICOPTER

This year three of the nationalised companies showed helicopters. The Alouette II, shown in Fig. 7, is the production version of the

Fig. 8 The SNCASO Djinn helicopter, reaction driven by cold jets at the blade tips, shown flying above the summit of the Jungfrau.

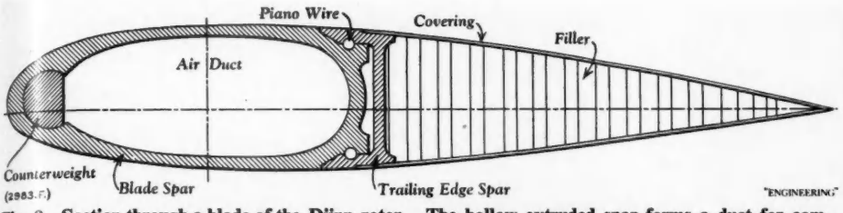


Fig. 9 Section through a blade of the Djinn rotor. The hollow extruded spar forms a duct for compressed air supplied by a Palouste turbo-compressor.

SNCASE. Alouette which in 1953 set up an international closed-circuit distance record, of 1,252 kilometres, for helicopters of all classes. The Alouette II has followed this up by establishing, on the eve of the show, a claim for the world height record for all classes of helicopters, with an altitude of 27,100 ft.

Three Alouette II helicopters are already on order for the French Navy. The 200-h.p. Salmson piston engine of the Alouette I (described on page 75 of the July 17, 1953, issue of ENGINEERING, vol. 176) has been replaced in the Alouette II by a Turboméca Artouste shaft turbine developing 360 h.p., and, consequently, the performance—as indicated by the altitude record—is much enhanced.

The Alouette II is a five-seat helicopter and has a useful load of 1,265 lb. At the maximum all-up weight of 2,980 lb., the aircraft has a rate of climb of 1,180 ft. per minute and a practical ceiling of 14,750 ft. The hovering ceiling, without ground effect, is 3,300 ft. It has a cruising speed of 106 m.p.h., and at this speed the endurance is 3 hours 15 minutes. The maximum range is about 320 miles.

As may be seen from the illustration, the view from the cabin is excellent. The helicopter is designed for diverse roles, including ambulance duties, providing accommodation for two stretcher cases carried outside the cabin and two seat patients in the cabin. Two large entry doors are provided. Maintenance has been facilitated by designing for accessibility, interchangeability and rapid dismantling.

DJINN HELICOPTER

The single-seat Djinn reaction-driven helicopter shown by Société Nationale de Constructions Aéronautiques du Sud-Ouest, 105 Avenue Raymond Poincaré, Paris (16), at the 1953 Salon has been followed by a two-seat version which is now in production. Shown in Fig. 8 is the two-seat Djinn which recently made history by establishing contact with the summit of the Jungfrau (11,320 ft.) and landing on the summit of Mönch (13,124 ft.).

The Djinn, it may be recalled, is driven by cold compressed-air jets at the tips of its two-blade rotor, the compressed air being supplied by a Turboméca Palouste turbo-compressor. Fig. 9 shows a section through one of the all-metal blades. The hollow extruded light-alloy spar, the cross-section of which varies along the spar, forms a duct for the air which is ejected at the tips through nozzles at 90 deg. to the blade axis. At the forward part of the spar is a steel counterweight to balance the blade. The blade trailing edge comprises a small spar to which are attached a series of "boxes" of light-alloy sheet stiffened with a plastics honeycomb filler. It is attached to the main spar by means of piano wire.

The cold-air jet drive, although not economical in fuel consumption, has the advantage of a low installation weight, and greatly reduced maintenance since both mechanical transmission and complicated fuel-ducting and combustion systems are eliminated. The Djinn is of simple construction and, therefore, the first cost is low. On balance, it is claimed, the operating costs of the Djinn are lower than those of any comparable helicopter at present available. In the two-seat version, the maximum permissible all-up weight is 1,540 lb. The normal total weight, however, is 1,400 lb. The fuel capacity is 55 Imperial gallons. At the maximum weight, the rate of climb is 415 ft. per minute and the ceiling is 4,900 ft. in standard atmosphere conditions. The ceiling increases by 1,000 ft. for every 33 lb. reduction in weight. Hovering is possible at sea level, with ground effect, at a weight of slightly over 1,440 lb.; beyond ground effect, at an altitude of, say, 33 ft. above sea level, the maximum hovering weight is 1,300 lb., decreasing by about 25 lb. per 1,000 ft. of altitude. At a cruising speed of 62 m.p.h., the maximum range is 125 statute miles, the maximum endurance, attained at a speed of 44 m.p.h., is 2 hours 20 minutes, with a corresponding payload of 240 lb. If a payload of 490 lb. is carried, the endurance is reduced to 1 hour.

NORELFE HELICOPTER

Société Nationale de Constructions Aéronautiques du Nord, 12 Rue Béranger, Châtillon-sous-Bagneux, are now constructing under licence from Aerotechnica Industrial S.A., Madrid, a three-seat helicopter designed in 1953 by the French engineer Jean Cantineau. Known as the Nord 1750 AC13 Norelfe, it is suitable for touring or taxi work, agricultural applications, ambulance duties or as an air observation post. It is powered by a 280-h.p. Turboméca Artouste gas turbine. Although employing shaft transmission, the Norelfe is a true single-rotor machine, torque counteraction and directional control being provided by deflecting the exhaust jet through an articulated tailpipe and two lateral branch pipes. Up to a speed of 80 km. per hour, the deflected main exhaust pipe provides the necessary control. Above this speed, the main jet is restored to the longitudinal axis of the machine to reduce drag; torque reaction and directional control are then provided by the lateral exhaust branch pipes which are controlled by pedals in the cockpit.

The fuselage, of tubular construction, is covered in light-alloy sheet, and is mounted on a skid-type undercarriage. The fuel capacity is 22 Imperial gallons.

The leading particulars of the Norelfe are as follows: length, 26·1 ft.; height, 8·9 ft.; rotor diameter, 29·6 ft.; disc area (three-blade rotor), 660 sq. ft.; rotor speed, 360 r.p.m. At the maximum all-up weight of 1,870 lb., the Norelfe has a maximum speed of 90 m.p.h. and a cruising speed of 75 m.p.h. In forward flight, the rate of climb is 790 ft. per minute and the ceiling is 15,000 ft. For hovering the ceiling is 2,600 ft.

To be continued

45-IN. CYCLOTRON AT HAMMERSMITH

LATEST APPLICATION OF NUCLEAR PHYSICS TO MEDICINE

Five years ago the Medical Research Council authorised the construction of a 45-in. cyclotron by the Radiotherapeutic Research Unit at Hammersmith Hospital, London, W.12, and the machine, which is now practically complete, was switched on from the control room for the first time by H.M. the Queen on Monday, June 6. Some time must elapse before it can be brought into routine operation, but it will then be used for the production of neutron beams and beams of fast charged particles, such as deuterons, protons and alpha-particles, which are frequently employed in radiobiology and radiation chemistry. It can also be used for the production of certain radioactive isotopes. The machine has been designed and assembled by a team specially collected for the purpose by Mr. J. W. Gallop.

The new building in which the Research Unit is now housed is 250 ft. long and 48 ft. wide and is located in the north-east corner of the hospital grounds running almost due north and south. It is four stories in height, except at the northern and southern ends, where the cyclotron and a linear accelerator, respectively, are situated; the end portions are two stories and one storey in height. The cyclotron is erected above ground level in a chamber measuring internally 44 ft. long, 20 ft. wide and 13 ft. in height, the walls and ceiling being of concrete 6 ft. in thickness except at the southern end where the thickness is 10 ft. A large door in this wall gives access to the assembly bay. The door, shown in Fig. 1, weighs 190 tons and when opened moves on rollers into a "garage" on the west side of the building; when closed, it fits into the walls and ceiling with a maximum clearance of $\frac{1}{4}$ in. A double-lift drawbridge, also shown in Fig. 1, closes over the pit when the door is opened and enables the whole of the electrode-vacuum assembly of the cyclotron to be wheeled out on a trolley running on rails into the assembly bay. This is provided with

Fig. 1 190-ton concrete sliding door, showing drawbridge over which parts of the cyclotron can be moved into the assembly bay.

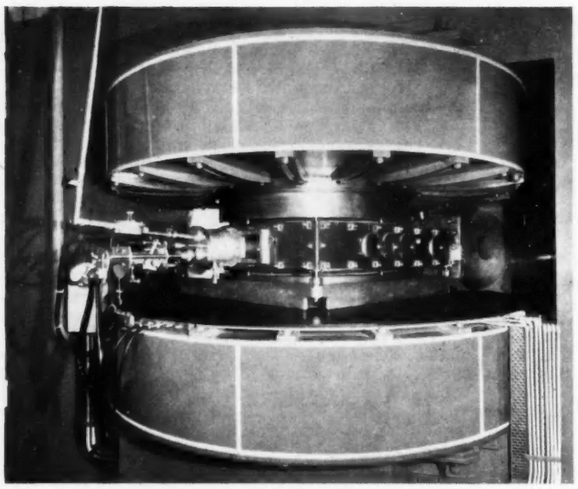


Fig. 2 Magnet yoke, showing field coils and poles. To the left of the dee box between the poles, the gate valves and the mechanism for adjusting the ion source can be seen.

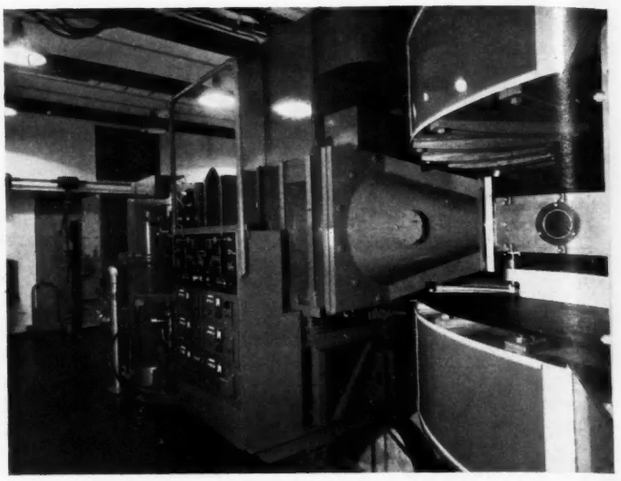


Fig. 3 Dee box and vacuum-tight chamber enclosing the dee stems. One of the 16-in. oil-diffusion vacuum pumps can be seen to the left of the local vacuum-control panel.

two overhead runways with 5-ton blocks and tackle for handling the heavy parts. The west wall of the assembly bay is formed by a glass-panelled folding door opening on to the roadway. Access to the radiation room, which is the space to the north of the cyclotron magnet, is by means of a door in the east wall of the cyclotron chamber. This door is of steel-loaded concrete 3 ft. in thickness and weighs 35 tons; it is operated in a similar manner to the southern door and when fully closed uncovers a water window through which the cyclotron can be viewed while in operation.

PLANT ROOMS

Two plant rooms run along the outside of the eastern wall of the cyclotron chamber. In the ground-floor room are a 165-kW motor-generator and control gear for supplying energising current to the magnet, an auxiliary motor-generator set and the high-voltage rectifier that feeds the radio-frequency power amplifier. On the first floor of the plant room are the battery room, the high-voltage deflector set and the radio-frequency driver stage for the power amplifier which supplies radio-frequency current to the "dees." The plant rooms are connected to the cyclotron chamber by ducts 9 in. in internal diameter passing through the wall at an acute angle. At the north-east corner of the cyclotron building, on the first floor, are located the heat exchangers for the cyclotron and the air-conditioning plant for the chamber. The air conditioning is designed to keep the relative humidity of the chamber below 50 per cent. in order to avoid rusting of the machine. The air is drawn in over cotton-flock filters and delivered to the chamber through a labyrinth, past a bank of 15-kW heaters. On the roof of the chamber is a small house containing the evaporative coolers which dissipate the heat losses, equivalent to 300 kW, when the cyclotron is running. On the east side of the building are two floors of laboratories and on the ground floor, at the northern end, are the target-chemistry laboratory and two general-purpose rooms used for setting up experimental equipment and for the accommodation of patients.

PRINCIPLE OF THE CYCLOTRON

Regarding the general principle of the cyclotron itself it will be remembered that charged particles or ions, are produced at the centre of a pair of shallow semi-circular boxes known as "dees" located in a powerful transverse magnetic field with a diametral gap between them. The particles are attracted into one or other of the dees, according to its potential, and on entering the dee, traverse it in a semi-circular path under the action of the transverse magnetic field. On leaving the dee at the gap they are attracted into the other dee the potential of which has changed to the opposite sign in the meantime. The particles are accelerated in the gap and as the time taken to traverse the semi-circular path is constant, irrespective of the radius, the increased velocity causes an increase of the radius of its path each time the particle crosses the gap. The potential of the dees is changed at radio-frequency and as the particles traverse the two dees in one cycle they attain a very high velocity and the resulting increase in the radius of the path brings them to the circumference of the dees from which they are deflected tangentially by a curved plate maintained at a constant high potential. The dees, and a chamber enclosing them, must, of course, be maintained at a very high vacuum.

MAGNET WITH FIELD COILS OF ALUMINIUM TUBE

The rectangular yoke of the electromagnet for the Hammersmith cyclotron is formed of solid forged-steel blocks, the horizontal members weighing about 32 tons and the vertical members about 14½ tons. The magnet was designed, constructed and erected by C. A. Parsons and Company, Limited, Newcastle-upon-Tyne. The two poles attached to the upper and lower horizontal members are formed by flat discs, 57 in. in diameter and 22 in. and 8·68 in. in thickness, respectively. The field coils are formed of aluminium tubes of rectangular cross section, measuring 1·15 in. by 0·75 in., and having an internal hole 0·4 in. in diameter. There are two coils, each of 408 turns and carrying a current of 560 amperes at full load. They give a maximum field of 17 kilogauss across a total effective gap of 8 in. The pole faces are parallel and concentric to within 0·0035 in. and 0·005 in., respectively. The complete magnet, best shown in Fig. 2, stands on a plinth composed of a steel framework bolted to the floor and concreted in position and it may be mentioned that the axis of the magnet is set at an angle of 30 deg. to the east-west direction so that the beam of radiation shall leave the dee box in a direction roughly perpendicular to the face of the magnet. Distilled water is circulated through the hollow conductors of the field coils for cooling purposes.

VACUUM SYSTEM

The lids of the vacuum box in which the dees are enclosed, shown in Fig. 2, form the pole faces of the magnet and are constructed of Armco iron; they are 3 in. in thickness and are copper plated on the inner faces. The vacuum box itself is a brazed assembly of rolled brass. On one side of this vacuum box and communicating with it is a much larger vacuum-tight chamber partly conical and partly cylindrical in form, as shown in Fig. 3, which encloses two hollow stems extending from the dees. At the frequency at which the cyclotron operates it is difficult to find a satisfactory material for insulating the dees from earth, so their supports are made of such a length that their inductance resonates with the capacitance of the dees, thus producing a quarter-wave stub. The stems are mounted on gimbals situated behind a flexible short circuit to enable any deviations in the positions of the dees due to heat expansion to be corrected by remote control while the machine is in operation. The dees, which were made by Lee and Wilkes, Limited, Birmingham, are water cooled. The short circuit is composed of 48 water-cooled S-shaped copper tubes fixed to water-cooled T-section copper pipes soldered to the parallel-section copper liner and dee-stem casings, respectively. This design presents the minimum obstruction to the vacuum pumps, is flexible enough to permit movement of the dee stems and is sufficiently effective to prevent leakage of radio-frequency power.

The ion source at the centre of the dees is of the hooded type and uses a hair-pin shaped tungsten-filament set vertically in the arc chamber below the hood or chimney. The filament is fed from a 500-ampere six-volt generator and

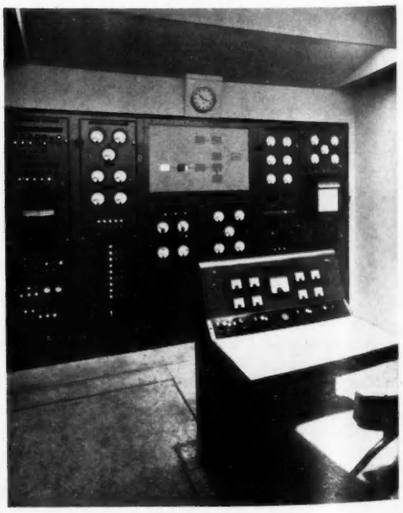
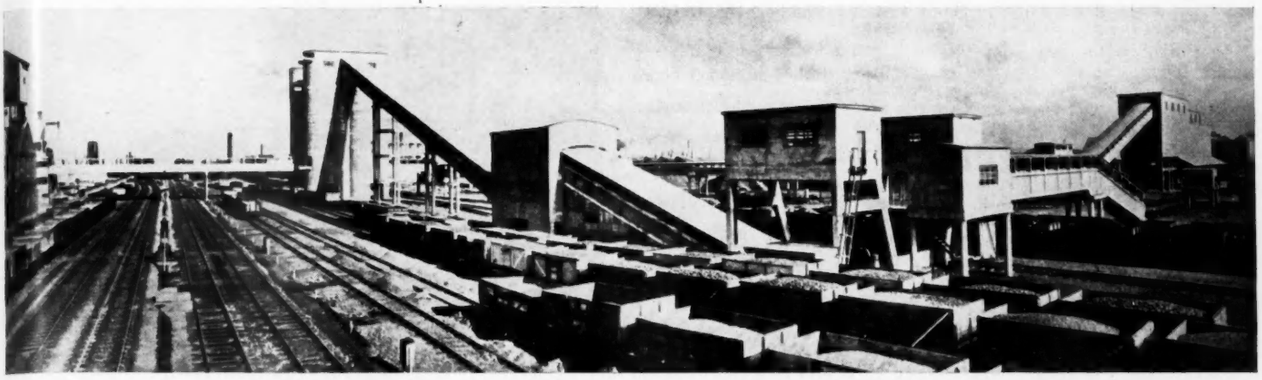


Fig. 4 Control room, showing instrument panel and controller's desk.



In the new plant at Tottenham gasworks extensive use has been made of conveyors controlled from remote panels.

the power for the arc is supplied by a 600-volt six-ampere mercury-arc rectifier. By controlling the rate of flow of gas into the arc chamber the pressure is raised until an arc is struck. The electrons from this arc are collimated by the magnetic field and move vertically away from the filament and then pass into the chimney where they ionise the gas as it passes into the dee chamber through a slot in the side. Hydrogen is supplied when protons are required, heavy hydrogen for deuterons and helium for alpha particles. The filament and the hood can both be withdrawn through gate valves and the position of the ion-source head is adjustable in three directions from outside the dee box.

For maintaining the vacuum in the system two 16-in. B.A.R. oil-diffusion pumps, one of which can be seen on the left in Fig. 3, backed by two Kinney mechanical pumps, with a total capacity of 200 cub. ft. per minute, are provided. A panel for the local control of the vacuum system can also be seen in Fig. 3. The combination, with refrigerated baffles, has a pumping speed of 4,000 litres per second at 10^{-5} mm. Hg. for a vacuum-system volume of 4,000 litres. A pressure of 5×10^{-5} mm. of Hg can be attained in two hours, but the ultimate pressure of 5×10^{-6} mm. of Hg requires two days to reach. The vacuum pumps and the rest of the electrode system are cooled by distilled water passing through a system similar to that for the magnet; the only difference being that the circulating system for the vacuum pumps and electrodes is of copper throughout whereas that for the magnet is of aluminium and stainless steel in order to minimise the possibility of electrolysis. The radio-frequency system comprises four crystal-controlled transmitters having a total output of 12 kW which drive two neutralised B.W.165 three-electrode valves forming the power amplifier. These valves have an anode dissipation of 22·5 kW. The whole system has a maximum output of 75 kW and operates at a fixed frequency of 11·286 Mc/s.

CONTROL ROOM

Careful attention has been given to the design and layout of the control room, illustrated in Fig. 4, in order to minimise fatigue of the operator who may be on duty for long periods. To avoid reflections, daylight has been excluded and the bank of lights over the instrument panel gives a uniform illumination which can be reduced at will. The whole machine can be operated from the control desk, reference to the instrument panel behind it being only necessary in the event of a fault developing or when starting up. Normally, another operator, who is in charge of the experiments being carried out, will be stationed in a position from which he can observe the machine through water window.

Although, as stated at the outset, the cyclotron has not yet been fully commissioned, preliminary trials have been carried out and an internal beam of 30-MeV alpha particles has been obtained. Beam currents of up to 750 microamperes of single-charged hydrogen molecular ions have been measured at a radius of 6 in.

TOTTENHAM GASWORKS EXTENSIONS

USE OF CONVEYORS AND REMOTE CONTROL PANELS

A striking feature of a new extension to the Willoughby Lane Gasworks, Tottenham, opened on June 17 by Sir John W. Stephenson, C.B.E., J.P., chairman of the Eastern Gas Board, is the extensive use made of conveyors, both for the incoming coal and the outgoing coke. The handling of these two materials, in fact, is controlled by three or four men working at remote control panels.

The gasworks stand on a roomy site having a total area of 98·4 acres, divided, however, into four sections by the north to south Cambridge line of British Railways' Eastern Region, and by a public footway running from east to west. The retort houses and other gas-making plant are concentrated on the west side of the railway line, and when it was decided to build a new retort installation this was erected alongside the existing plant; all the coal and coke handling and storage plant was moved on to the land on the east side of the railway but was linked to the gas-producing plant by a conveyor gantry built over the British Railways property.

The gas-making plant at the Willoughby Lane Works consists of an intermittent vertical-chamber house and a carburetted water-gas plant and the newly opened continuous vertical-retort installation. The intermittent vertical chamber plant, installed in 1933 and extended in 1939, is capable of making 5·7 million cub. ft. of gas a day, the calorific value of which is 540 B.Th.U. per cub. ft. The carburetted water-gas plant, installed between 1945 and 1952, produces 8·8 million cub. ft. a day of a gas having a calorific value of 500 B.Th.U. per cu. ft.

The new continuous vertical-retort installation is capable of producing 8 million cub. ft. of gas and 360 tons of domestic coke a day, the calorific value of the gas being 500 B.Th.U. per cub. ft. The new plant comprises sixty-four 82-in. retorts arranged in four benches and fired by means of the " Lambent Heating " system, there being 12 external step-grate producers arranged in four groups of three. Inferior grades of coke from the intermittent vertical-chamber installation are consumed in the carburetted water-gas plant, and at a rate of between 55 and 60 tons a day, in the new step-grate producers. The waste gases from the retorts are used for heating three waste-heat boilers. An exterior view of the new retort house is shown in the illustration below. The conveyor nearest the front of the picture takes coke from the retort house to the coke storage installation and that behind takes coal to the retort-house bunkers. The building on the extreme right of the illustration is the power house. This contains three 300-kW engine-driven alternators which take steam from the waste-heat boilers. The boilers generate steam at 275 lb. per square inch pressure, superheated by 200 deg. F. The steam supply from the boilers is entirely absorbed in the generation of electric power. The generator engines exhaust at 30 lb. per square inch, and the exhaust steam is used in both retort houses for benzol extraction and in other processes.

A general view of a portion of the handling and storage plant is seen in the photograph shown above. The gas-making plant is at the extreme left and almost entirely out of sight. The conveyor gantry, over the railway line brings incoming coal to the retort houses from three coal storage bunkers each having at capacity of 600 tons (seen in the left centre) and takes outgoing coke to the coke grading plant.

New continuous vertical-retort house with, in front, the outgoing coke conveyor and, behind this, the incoming coal conveyor. On the extreme right is the power house, the engines of which are driven by steam from the waste heat of the gas retort houses.

This gantry spans the four tracks of British Railways and the Gas Board's sidings. On the extreme right is the new coke screening and loading plant; in the right centre are seen two wagon-tippler and automatic weighing-machine houses. Each wagon tippler can handle 20 wagons an hour. From the wagon tipplers two 48-in. 240 tons per hour conveyors take the coal to the coal-breaker house shown in the centre of the illustration. From these the crushed coal is elevated by belt-conveyor and discharged into the coal storage bunkers. One of these contains clean Yorkshire or East Midlands coals. The second bunker contains Durham coals and the third contains low-swelling coals and coals of high shale content, to be blended with the Durham coals. Blending is effected by feeding on to belt conveyors through adjustable vibrating feeders. Band conveyors finally distribute the coal to the retort houses.

The coal stocking ground measures 920 ft. by 157 ft. 6 in. and can hold 52,000 tons of coal stacked to a depth of 18 ft. It is spanned by a travelling transporter having a 2½-ton capacity grab operating on a transverse movement at a rate of 100 tons an hour. Coal can be delivered from any of the storage bunkers at a rate of 100 tons an hour and taken to the stocking ground by a band conveyor. The coal is discharged from the conveyor into a sunken bay adjacent to it and running the full length of the western side of the coal heap. The coal is subsequently moved transversely into the heap by the transporter at a convenient time. Coal taken from the stocking ground for return to the coal bunkers is loaded by the transporter on to a belt on the eastern side of the stocking ground. This belt conveys the coal back to the storage bunkers also at a rate of 100 tons an hour. The whole of the stocking and reclaiming of coal is carried out by the transporter driver.

In the new continuous vertical-retort installation duplicated band conveyors, running beneath the retort extractor boxes, take the discharged coke to a central position. Here, two further duplicated conveyors, running in a subway beneath the boiler house and the power house, take the coke at a rate of 35 tons an hour to the base of a transfer tower whence it is conveyed to the screening plant. Nine coke hoppers are provided having a total capacity of 730 tons. The hoppers are fitted with de-breezing screens and weighing machines for sack filling or for bulk delivery to rail wagons or road vehicles.

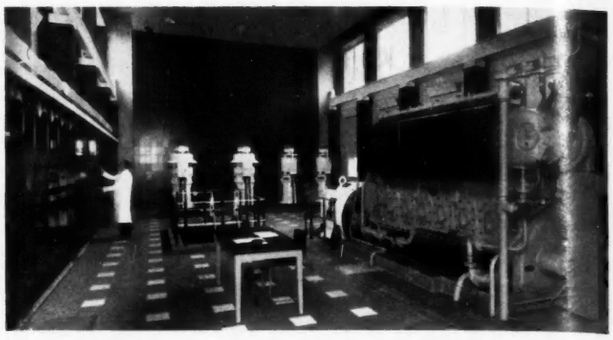
Alternatively coke may be put into stock by means of a chain of electrically interlinked portable conveyors fed from a discharge point on the conveyor leading to the screens.

CONTROL OF HANDLING PLANT

The electrical plant of the coal and coke conveyors is divided into four sections each comprising three or more electrically-controlled flow sequences, namely, (*a*) coal from the wagon tipplers and from stock to the storage bunkers, (*b*) coal from the storage bunkers to the retort houses and to stock, (*c*) coke from the continuous vertical retorts to the coke-grading plant and to stock, and (*d*) coke from the intermittent vertical-chamber plant to the continuous vertical retort house and carburetted water-gas plant. The control gear for each of the four sections is grouped in positions most convenient for the operator concerned and, with the exception of sequence (*a*), mimic diagrams are provided to indicate the sequence in operation.

The general planning of the extensions, which have cost some £1½ million, were undertaken by the Board's engineering staff; among the contractors for plant and services were the Woodall-Duckham Construction Company, Limited, which supplied the carbonising plant, and Peter Lind and Company, Limited, which carried out the foundations and erected the concrete structures. Hugh Wood and Company, Limited, supplied the belt conveyors; the Fraser and Chalmers Engineering Works, the wagon tipplers; British Jeffrey-Diamond, Limited, the coal crushers; and Babcock and Wilcox, Limited, the transporter.

Two bore-hole and two booster pumps are installed in the new Sawbridgeworth pumping station. Stand-by power is provided by a 693-b.h.p. Diesel alternator set.



PUMPING STATION INAUGURATED

Expansion to Supply New Town

The Hertfordshire and Essex Water Company officially inaugurated a new pumping station at Redricks-lane, Sawbridgeworth, on June 17. The area served by the company runs from Bishops Stortford almost to Romford and includes the towns of Epping, Ongar, Sawbridgeworth, and the old and new towns at Harlow. It is largely the rapid development of the last that has necessitated the new plant. All the water is drawn from bore-holes. The company, originally formed in 1879, was re-organised and re-incorporated in 1953 to have the necessary powers to handle the requirements.

As the original pumping machinery, driven by a Hathorn Davey triple-expansion steam engine, was in operation 24 hours a day to cope with the demand, it was not possible to install the new electric plant in the same buildings, and therefore a site immediately adjacent was chosen. The new buildings are immediately over a pilot shaft 7 ft. in diameter which was sunk in 1929 and to which headings have since been added to the extent of about 580 yards. All existing wells and headings connect to this shaft through 12-in. mains and valves. The chief engineer of the company, Mr. J. G. Shaw, was responsible for the engineering design of the new station, and the architect was Mr. H. R. Hayhoe, of Messrs. Scherrer and Hicks. The electrical equipment was supplied by Lancashire Dynamo and Crypto, Ltd., and Erskine Heap, Ltd.

Water is raised from a depth of about 180 ft. by two vertical-spindle centrifugal Sulzer pumps, running in parallel. These are driven by variable-speed motors giving a maximum output for the two of 120,000 gallons per hour. The discharge is through a metering Venturi to a surface aeration tank. The flow through the Venturi controls the addition of chlorine to the water. From the aeration and contact tank, the water is pumped into the distribution system by another pair of Sulzer pumps of the same capacity as the bore-hole pumps, but having five stages instead of four to deal with the greater head. These pumps can be seen in the background of the illustration; the bore-hole pair are on the right and the boosters on the left. All pipe-work is run in the basement of the building and is easily accessible.

The room in which the chlorinating plant is contained is sealed from the main hall but is visible through glass. Entry can only be made from outside the building. Electroflo measuring and recording instruments mounted on the panel at the left in the illustration indicate the water flow. This panel also contains the electrical control gear for the pump motors. Supply to the panel is normally from the grid, but may also be from a stand-by direct-current alternator driven by a seven-cylinder turbo-charged Ruston and Hornsby Diesel engine of 693 brake horse-power. This can be seen in the right foreground. There is a separate compressor for the air-starting equipment. Circulating water for the engine is cooled in heat exchangers in the basement.

The generating set is mounted on a plinth separate from the floor of the hall, and the mass concrete bed rests on a layer of 2-in. thick cork blocks to prevent vibrations being carried to the foundations. Floor and walls are tiled, and the ceiling is finished with acoustic tiles to reduce noise. The block includes mess and rest rooms, a workshop and an office for the supply superintendent.

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NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

BOURNEMOUTH
Discussion on "Electrical Installations from the Woman's Viewpoint." Bournemouth Branch. Joint meeting with the Electrical Association for Women. Grand Hotel, Bournemouth. Sat., June 25, 7.15 p.m.

British Institute of Management

LONDON
"The Scientific Method and Human Relations," by Professor C. A. Coulson. Annual Lecture, organised by the London Students' Section of the Institute of Industrial Administration, which is incorporated with the British Institute of Management. Wed., June 29, 7 p.m.

Institute of Petroleum

LONDON
Symposium on "The Story of the Co-ordinating Research Council of the United States," comprising "The Development and Aims of the Co-ordinating Research Council," by M. K. McLeod; "Current Projects of the Council," by T. B. Rendel; "What the Council Means to the Automotive Industry," by E. S. MacPherson; and "What the Council Means to the Petroleum Industry," by W. J. Sweeney. Meeting arranged in co-operation with the Council. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., June 30, 3.30 p.m. and 5.30 p.m.

Institute of Physics

GLASGOW
Summer Meeting, Non-Destructive Testing Group. Royal Technical College, Glasgow. Wed., June 22, to Sat., June 25. "An Assessment of Ultrasonic Techniques, with Special Reference to Welds," by H. L. Carson; and "Problems in the Interpretation of Ultrasonic Tests on Steel," by I. M. MacKenzie and R. Kennedy, at 9.15 a.m. Works Visits and Evening Excursion, from 1.30 p.m. onwards. Fri., June 24. "Neutron Radiography," by Dr. J. Thewlis and R. T. P. Derbyshire; and Discussion on "Research Work Required to Promote Progress in the Field of Non-Destructive Testing," opened with a paper on "The Scope of Non-Destructive Testing," by Dr. E. G. Stanford. Sat., June 25, 9.30 a.m.

Institution of Highway Engineers

LONDON
Film on "Highways for To-morrow." Annual General Meeting. Institution of Structural Engineers, 11 Upper Belgrave-street, S.W.1. Fri., July 1, 5.30 p.m.

Royal Sanitary Institute

DURHAM
Various papers, including "The Durham Towns: Their Economic and Social Significance," by A. V. Williams. Durham Sessional Meeting. Shire Hall, Durham. Fri., July 1, 10 a.m.

Society of Chemical Industry

BIRMINGHAM
Annual General Meeting. Various papers, visits and excursions. Held under auspices of Birmingham and Midland Sections. Grand Hotel, Birmingham. Mon., July 11, to Sat., July 16.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Institute of Management, Management House, 8 Hill-street, London, W.1. (GROsvenor 6000.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Physics, 47 Belgrave-square, London, S.W.1. (SLOane 9806.)
Institution of Highway Engineers, 47 Victoria-street, London, S.W.1. (ABBey 3891.)
Royal Sanitary Institute, 90 Buckingham Palace-road, London, S.W.1. (SLOane 5134.)
Society of Chemical Industry, 56 Victoria-street, London, S.W.1. (VICtoria 5215.)

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list appears in the last issue of each month. Events appearing for the first time, and alterations of dates, places, etc., are indicated by an asterisk (*). Particulars of forthcoming exhibitions and conferences not included below may have appeared in ENGINEERING, *April 29, page 546; or May 27, page 679. Organisers are invited to send to the Editor particulars of forthcoming events as soon as arrangements are made.*

BRITISH INSTRUMENT INDUSTRIES EXHIBITION.—Tues., June 28, to Sat., July 9, at Earl's Court, London, S.W.5. Organised by F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 0568.

PRINTING, MACHINERY AND ALLIED TRADES EXHIBITION (IPEX).—Tues., July 5, to Sat., July 16, at Olympia, London, W.14. Promoted by the Association of British Manufacturers of Printers' Machinery (Proprietary) Ltd., Clifford's Inn, London, E.C.4. Organisers: F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 0568.

*STATISTICAL QUALITY CONTROL, EUROPEAN CONFERENCE ON.—Mon., July 11, to Wed., July, 13 in Paris. Organised by the Organisation for European Economic Co-operation. Apply to the European Productivity Agency, 3 Rue André Pascal, Paris 16e.

GREAT YORKSHIRE AGRICULTURAL SHOW.—Tues., July 12, to Thurs., July 14, at Harrogate, Yorkshire. Organised by the Yorkshire Agricultural Society, Cliftonfield, Shipton-road, York. Tel. York 3102.

NATURALLY-OCCURRING NITROGEN HETEROCYCLIC COMPOUNDS, SYMPOSIUM ON.—WED., July 13, to Fri., July 15, at the University College of the South West of England, Exeter. Organised by the Chemical Society, Burlington House, Piccadilly, London, W.1. Tel. REGent 0675. Apply to Dr. K. Schofield, Washington-Singer Laboratories, Prince of Wales-road, Exeter.

DRY CLEANING, DYEING AND ALLIED TRADES EXHIBITION.—Fri., July 15, to Sun., July 24, at the Ausstellungspark, Munich. Organised by the Internationale Fachausstellung Chemisch-Reinigung und Färberei, Geschäftsstelle, Munich 12, Germany.

WATER SUPPLY CONGRESS AND EXHIBITION (INTERNATIONAL).—Mon., July 18, to Sat., July 23, at Royal Horticultural Society's Halls, Vincent-square, London, S.W.1. Organised by the International Water Supply Association, 34 Park-street, London, W.1. Tel. GROsvenor 1092. See ENGINEERING, March 11, page 304.

AMERICAN POULTRY AND HATCHERY FEDERATION'S ANNUAL CONVENTION.—Tues., July 19, to Fri., July 22, at St. Louis, Mo., U.S.A. Agricultural and dairy machinery exhibits. Apply to the Federation's offices, 521 East 53rd-street, Kansas City 10, Mo., U.S.A.

PURE AND APPLIED CHEMISTRY, INTERNATIONAL CONGRESS OF.—Thurs., July 21, to Wed., July 27, at Zürich. Organised by the International Union of Pure and Applied Chemistry, the 18th conference of which will be held, also at Zürich, from Wed., July 20, to Thurs., July 28. Apply to the Chemical Society, Burlington House, Piccadilly, London, W.1. Tel. REGent 0675.

SKANE (SWEDISH NATIONAL) FAIR (37TH).—Sat., July 23, to Sun., July 31, at Malmö. Organised by Skanemassan Kommissariat, Stora Nygatan 15, Malmö, Sweden.

AUSTRIAN INTERNATIONAL EXPORT AND TRADE FAIR.—Fri., July 29, to Sun., Aug. 7, at Dornbirn, Austria. Organised by Export-U Mustermesse G.m.b.H., Dornbirn. *Agents:* British Austrian Chamber of Commerce, 29 Dorset-square, London, N.W.1. Tel. PADdington 7646.

AGRICULTURAL SHOW.—Sat., July 30, to Mon., Aug. 1, at Lusaka. Organised by the Northern Rhodesia Agricultural Society, Lusaka.

ATOMIC ENERGY FOR INDUSTRIAL USE, EXHIBITION.—Mon., Aug. 8, to Sat., Aug. 20, at Geneva, under the sponsorship of the United Nations Organisation. Some six countries, including the United States, are expected to participate. Apply to the United Kingdom Atomic Energy Authority, 1-13 St. Giles High-street, London, W.C.2.

ROYAL NATIONAL AGRICULTURAL AND INDUSTRIAL EXHIBITION.—Thurs., Aug. 11, to Sat., Aug. 20, at Brisbane. Organised by the Royal National Agricultural and Industrial Association, 99 Creek-street, Brisbane, Australia.

*MOTOR SHOW.—Fri., Aug. 12, to Sat., Aug. 20, in Sydney. Organised by the Chamber of Automotive Industries, 75 William-street, Sydney, N.S.W.

AUTOMOTIVE ENGINEERS, SOCIETY OF.—*West Coast Meeting:* Mon., Aug. 15, to Wed., Aug. 17, at Portland, Oregon. *Aircraft Production Forum and Aircraft Engineering Display:* Tues., Oct. 11, to Sat., Oct. 15, at Los Angeles. *Transportation Meeting:* Mon., Oct. 31, to Wed., Nov. 2, at St. Louis, Miss. *Diesel Engine Meeting:* Wed., Nov. 2, to Fri., Nov. 4. Apply to the Society of Automotive Engineers, 29 West 39th-street, New York, 18.

*MANAGEMENT CONFERENCE.—Fri., Aug. 19, to Sat., Aug. 27, at the University of Connecticut. Sponsored by the University and the Society for the Advancement of Management. Apply to Mr. Joseph Emerzian, University of Connecticut, Storrs, Conn., U.S.A.

MOTOR INDUSTRY SUMMER SCHOOL.—Sat., Aug. 20, to Sat., Aug. 27, at Corpus Christi College, Cambridge. Organised by the Institute of the Motor Industry, 40 Queen's Gate, London, S.W.7. Tel. WEStern 0915. See ENGINEERING, December 10, 1954, page 772.

NATIONAL RADIO SHOW.—Wed., Aug. 24, to Sat., Sept. 3, at Earl's Court, London, S.W.5. Organised by the Radio Industry Council, 59 Russell-square, London, W.C.1. Tel. MUSeum 6901.

*PACIFIC NATIONAL EXHIBITION.—Wed., Aug. 24, to Mon., Sept. 5, at Vancouver. Organiser: Mr. Ben Williams, Exhibition Park, Vancouver, B.C.

*CANADIAN NATIONAL EXHIBITION.—Fri., Aug. 26, to Sat., Sept. 10, at Toronto. Information obtainable from Mr. G. H. Ward, 3, Lower Regent-street, London, S.W.1. Tel. WHItehall 2794.

GERMAN RADIO, GRAMOPHONE AND TELEVISION EXHIBITION.—Fri., Aug. 26, to Sun., Sept. 4, at Düsseldorf. Agents: John E. Buck & Co., 47 Brewer-street, London, W.1. Tel. GERrard 7576.

*MINNESOTA STATE FAIR.—Sat., Aug. 27, to Mon., Sept. 5. Apply to the British Consulate, First National Bank Building, St. Paul 1, Minn., U.S.A.

*MELBOURNE INTERNATIONAL TRADE FAIR AND MODELS EXHIBITION.—Sat., Aug. 27, to Sat., Sept. 10, at Exhibition Buildings, Melbourne. Apply to Rev. L. L. Elliott, 1, Lancaster-grove, London, N.W.3, Tel. PRImrose 7777; or to Miss J. H. Jeffery, 112 Maltravers-road, Ivanhoe, Melbourne.

PRESTRESSING, CONFERENCE ON.—Mon., Aug. 29, to Fri., Sept. 2, at the Royal Tropical Institute, Mauritskade 63, Amsterdam 0, Holland. Organised by the Fédération Internationale de la Précontrainte, Groningsestraat 15, The Hague. See ENGINEERING, December 17, 1954, page 782.

BRITISH ASSOCIATION MEETING.—Wed., Aug. 31, to Wed., Sept. 7., at Bristol. Apply to the secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1. Tel. REGent 2109. See ENGINEERING, February 11, page 168.

ENGINEERING, MARINE, WELDING AND FOUNDRY TRADES EXHIBITION (20TH).—Thurs., Sept. 1, to Thurs., Sept. 15, at Olympia, London, W.14. Organised by F. W. Bridges and Sons, Ltd., Grand Buildings, London, W.C.2. Tel. WHItehall 0568.

*PAKISTAN INTERNATIONAL INDUSTRIES FAIR.—Fri., Sept. 2, to Sun., Oct. 2, at Karachi. *Agents:* Auger and Turner Group Ltd., 40 Gerrard-street, London, W.1. Tel.: GERrard 6671.

STRASBOURG EUROPEAN FAIR.—Sat., Sept. 3, to Sun., Sept. 18, at Wacken, Strasbourg, France. *Agent:* R. C. Liebman, 178 Fleet-street, London, E.C.4. Tel. CITy 5889.

LEIPZIG INTERNATIONAL FAIR.—Autumn Fair: Sun., Sept. 4, to Fri., Sept. 9. Apply to Leipzig Fair Agency, 127 Oxford-street, London, W.1. Tel. GERrard 0357.

*CHICAGO EXHIBITIONS.—Tues., Sept. 6, to Sat., Sept. 17. Metal-Working Machinery and Equipment at the Coliseum; Machine Tools at the International Amphitheatre; and Production Equipment at the Navy Pier. Organisers: Exhibition and Convention Management, Inc., 2689 East Overlook-road, Cleveland 6, Ohio, U.S.A.

GHENT INTERNATIONAL FAIR, INCLUDING PRINTING AND PUBLISHING TRADES EXHIBITION and QUINQUENNIAL EXHIBITION OF SCIENTIFIC AND INDUSTRIAL LABORATORY EQUIPMENT.—Sat., Sept. 10, to Sun., Sept. 25, at Ghent, Belgium. *Agents:* S. R. Tippett & Co., Ltd., 110 Cannon-street, London, E.C.4. Tel. MANsion House 4500.

*LIBRARIES AND DOCUMENTATION CENTRES CONGRESS.—Sun., Sept. 11, to Sun., Sept. 18, at Brussels. Information obtainable from Aslib, 4 Palace-gate, London, W.8. Tel. WEStern 6321.

INSTRUMENT EXHIBITION AND CONFERENCE (10TH ANNUAL).—Mon., Sept. 12, to Fri., Sept. 16, at the Shrine Exposition Hall, Los Angeles. Organised by the Instrument Society of America, 3443 South Hill-street, Los Angeles 7, California, U.S.A.

COMPUTING MACHINERY CONGRESS.—Wed., Sept. 14, to Fri., Sept. 16, at the Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, U.S.A. Apply to Association for Computing Machinery, Building 13–2, Camden 2, New Jersey, U.S.A.

*WELLINGTON DIAMOND JUBILEE EXHIBITION.—Thurs., Sept. 15, to Sat., Oct. 1. Organised by the Wellington Manufacturers Association (G.P.O. Box 844), Manufacturers' Chambers, Corner of Willis and Ghuznee-streets, Wellington C.2, New Zealand.

IRON AND STEEL ENGINEERS, ASSOCIATION OF (AMERICAN).—*Annual Convention:* Mon., Sept. 26, to Thurs., Sept. 29, at Chicago. Apply to Association of Iron and Steel Engineers, Empire Building, Pittsburg 22, Pa., U.S.A.

TURIN INTERNATIONAL TECHNICAL EXHIBITION (FIFTH), also 7TH AGRICULTURAL ENGINEERING EXHIBITION and 15TH ENGINEERING EXHIBITION.—Wed., Sept. 28, to Sun., Oct. 9, in Turin. Exhibition offices: Via Massena, Turin, Italy.

ALL-BRITISH TRADE FAIR.—Thurs., Sept. 29, to Sun., Oct. 16, in the Tivoli Gardens and the Forum, Copenhagen, Denmark. Inquiries to the British Overseas Fairs, Ltd., 21 Tothill-street, London, S.W.1. Tel. WHItehall 6711. See ENGINEERING, July 16, 1954, page 69.

GERMAN PLASTICS INDUSTRY.—Sat., Oct. 8, to Sun., Oct. 16, at Düsseldorf, Germany. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Düsseldorf. *Agents:* John E. Buck & Co., 47 Brewer-street, London, W.1. Tel. GERrard 7576.

*LETTERPRESS METHODS CONFERENCE.—Wed., Oct. 12, to Sat., Oct. 15, at the Grand Hotel, Eastbourne. Arranged by the Printing, Packaging and Allied Trades Research Association, Patra House, Randalls-road, Leatherhead, Surrey. Tel. Leatherhead 4041.

*INDIAN INDUSTRIES EXHIBITION.—Sat., Oct. 29, to Thurs., Dec. 15, in Delhi. *Agents:* Auger and Turner Group Ltd., 40 Gerrard-street, London, W.1. Tel. GERrard 6671.

*CANADA'S POWER SHOW.—Tues., Nov. 8, to Fri., Nov. 11, at the Show Mart Building, Montreal. Sponsored by the Institute of Power Engineers, 1176 Sherbrooke-street West., Montreal.

*MODEL ENGINEERS' EXHIBITION (9TH INTERNATIONAL).—Sat., Nov. 12, to Thurs., Dec. 15, at Bombay. Apply to Mr. M. P. Polson, Noble Chambers, Parsi Bazar-street, Fort, Bombay.

AUTOMATION EXPOSITION (SECOND INTERNATIONAL).—Mon., Nov. 14, to Thurs., Nov. 17, at the Navy Pier, Chicago. Organised by Richard Rimbach Associates, 845 Ridge-avenue, Pittsburg 12, Pa., U.S.A.

CHICAGO EXPOSITION OF POWER AND MECHANICAL ENGINEERING.—Mon., Nov. 14, to Fri., Nov. 18, at the Coliseum, Chicago, Ill., U.S.A., under the auspices of the American Society of Mechanical Engineers. Apply to the International Exposition Co., 480 Lexington-avenue, New York 17, U.S.A.

CHEMICAL INDUSTRIES EXPOSITION.—Mon., Dec. 5, to Fri., Dec. 9, at the Commercial Museum and Convention Hall, Philadelphia, Pa., U.S.A. Organised by the International Exposition Co., 480 Lexington-avenue, New York 17.

*ROYAL AGRICULTURAL AND FOOD EXHIBITION.—Thurs., Jan. 12, to Thurs., Jan. 26, 1956, at the Ceylon Turf Club, Colombo. Agricultural and dairy machinery exhibits. Organised by the Exhibition Branch, Department of Commerce, P.O. Box 1507, Colombo, Ceylon.

*COPENHAGEN INTERNATIONAL FAIRS.—*Technical:* Fri., Mar. 16, to Sun., Mar. 25, 1956. *Trade:* Fri., April 6, to Sun., April 15, 1956. Apply to the offices, Forchhammersvej 13, Copenhagen V.

*AMERICAN SOCIETY OF TOOL ENGINEERS EXHIBITION.—Mon., Mar. 19, to Fri., Mar. 23, 1956, in the International Amphitheatre, Chicago. Apply to the American Society of Tool Engineers, 10700 Puritan-avenue, Detroit 21, Mich., U.S.A.

*ELECTRICAL ENGINEERS (A.S.E.E.) EXHIBITION (5TH).—Tues., Mar. 20, to Sat., Mar. 24, 1956, at Earl's Court, London, S.W.5. Organised by Electrical Engineers (ASEE) Ltd., 23 Bloomsbury-square, London, W.C.1. Tel.: MUSeum 3450.

Labour Notes

RAILWAY DISPUTE

The strike of some 60,000 engine men, which had reduced operations on British Railways to no more than one-sixth of their normal extent, was called off on the night of June 14, after lasting for 17 days.

Following all-day discussions at the Ministry of Labour on June 14, the final agreement reached between the parties was based upon proposals put forward by the British Transport Commission some days previously. There had been a deadlock for some time between the Commission and the Associated Society of Locomotive Engineers and Firemen, the members of which were on strike, regarding the union's demands that there should be a definite undertaking on the amount of the increase to be granted to engine drivers and that firemen should receive a further increase in pay at the end of their second year.

Eventually, it was agreed to appoint an independent referee to decide the amount of the increase in the basic rates of drivers and whether, and by what amount, the basic rates of firemen should be raised after their second year.

Sir Walter Monckton, the Minister of Labour, appointed Lord Justice Morris to act as referee and he began his hearings immediately. His report was presented to Sir Walter last Monday. By it, engine drivers will receive 1*s.*, 2*s.* and 3*s.* more at the end of their first, second and third years of service, respectively. Third-year firemen will not receive any extra. All parties had agreed in advance to accept the report without question.

The agreement reached on June 14 provided that negotiations between all three parties should begin within seven days on any outstanding matters, the most important of which appears to be the question of mileage allowances. The Commission undertook not to delay a settlement with the enginemen on account of negotiations with other unions, and the A.S.L.E.F. agreed that increases conceded to other grades should not, by themselves, be regarded as justifying further claims for its members.

This understanding seems to imply the end of the recent series of " leap-frogging " claims by the unions.

SEAMEN'S STRIKE

The energetic measures taken by the Cunard Steam Ship Company Limited at the end of last week, to deal with the unofficial strike of seamen at Liverpool and Southampton, have led to a drift back to work and hopes are entertained that the stoppage may collapse altogether within the next day or two.

The trouble began on May 31, when about 200 members of the company's liner Ascania walked off the ship at Liverpool after protesting about working hours and understaffing. The men shouted down the district secretary of their union, the National Union of Seamen, when he told them that they ought to return to work, and afterwards passed a vote of no confidence in the union.

Subsequently, the strikers compiled a list of six items, which they claimed to be the basis of the dispute. The main demands were for a reduction of working hours, improved living conditions, and the institution of safeguards against the employment of persons, whom they claimed to be inexperienced, at lower wages. The strike spread to other liners, both at Liverpool and Southampton, and caused much inconvenience and loss to passengers and shipping interests.

The principal sufferer has been the Cunard Company, which is estimated to have lost a substantial sum owing to the stoppage. On Saturday, the company announced that legal action, claiming damages and injunctions, had been started in the High Court against five men stated to be members of the strike committee at Southampton, and that summonses had been issued against 49 members of the crew of the Queen Mary for alleged disobedience to lawful orders. Earlier last week, routine notices were sent by the Ministry of Labour to some former members of the crews of the affected liners, warning them that they were presumed to have left the industry and that, being under the age of 26, they were due for national service.

NEED FOR COLLECTIVE DISCIPLINE

A very firm warning to the whole trade-union movement on the dangers of the improper use of strike action in industrial disputes was given by Mr. Jack Cooper, the chairman of the National Union of General and Municipal Workers, at the opening of the union's annual conference at Porthcawl, Glamorganshire, on June 13.

His strictures were the more worthy of attention in that they came not only from a high official of the third largest union in Britain, but that they had behind them the weight of a union which itself has grievances about declining differentials and a worsening of the relative position of its members in the public service.

Remarking that recent strikes were seriously threatening the country's security and vital international trade, Mr. Cooper said that some of them appeared to be following a new pattern. The right to strike was an essential economic freedom. It was, indeed, a fundamental human right, but such rights could only be retained if they were respected, and their security would be undermined if they were abused. Strikes should be used only as a last resort.

Unless the trade-union movement in general could apply a measure of discipline in the interest of healthy collective bargaining, it was simply inviting the Government to place restrictions on it in the interest of the community as a whole.

VOTES BEFORE STRIKES

In the development of its industrial relations, this country had moved away from an attitude of distrust and dependence on force, towards the more rational and advantageous system of collective bargaining, the success of which depended on good faith on the part of both sides.

Employers who were not prepared to be reasonable, but who yielded to threats, were, Mr. Cooper considered, undermining " decent relations " and encouraging strike action. Once workpeople became convinced that threats yielded better results than reasoned negotiations, the whole system of collective bargaining would collapse.

Of recent strikes, one had been caused rather by inter-union difficulties than by grievances against employers, and there were cases where " the tail had certainly wagged the dog " Much of the cause of recent difficulties had sprung from the autonomy which each union possessed and from the attitude of certain unions to stoppages of work, which had taken an unusual turn."

In conclusion, Mr. Cooper emphasised his view that all rank-and-file trade unionists should be allowed to vote properly before a strike affecting them was begun. If democratic rights were insisted upon, no man should be cajoled or bullied into strike action.

CLOSED SHOP ABANDONED

Some 400 delegates attended the annual conference of the Post Office Engineering Union, which was held at Southport, and opened on June 13. One of the most outstanding actions of the conference was the passing of a resolution agreeing to scrap the union's closed-shop policy, which has been in force for over 40 years.

The first clause of the organisation's constitutions, setting out its aims and intentions, declares that its adherents shall endeavour " to secure that membership of the union be a condition of employment within the grades covered by the union." An amendment, supported by 16 branches, proposed that this clause should be deleted, and this suggestion was approved, after discussion, by a substantial majority.

The union has a membership of more than 61,000 persons, employed by the engineering section of the Post Office in all parts of Great Britain and Northern Ireland.

DIFFICULTIES OF NEGOTIATION

In his presidential address to the conference, Mr. Leslie G. Fox complained that it was virtually impossible to negotiate any reasonable settlement on wages with the Post Office. He considered that this state of affairs was deplorable.

Arbitration Tribunal after Arbitration Tribunal, he stated, had proved by their awards that the attitude of the Post Office towards the normal wage-negotiating machinery was not that of a " responsibile employer." The Civil Service Arbitration Tribunal had become little more than a wage-fixing body for the Department, a function which was productive of anomalies in wage scales and embarrassing to both employer and employee. Considerable criticism of the Tribunal itself had resulted in consequence.

The patience of the union's members had been sorely tried by the delays which had accompanied the union's attempts to secure reasonable treatment by negotiation. It was fortunate, therefore, for the users of the Post Office telecommunications system that the engineering staff had " a real sense of their responsibilities to the general public and to the nation."

Mr. Fox expressed approval at the decision of the Post Office to spend some £80 million on capital development during the current financial year and affirmed that his union would insist upon a substantial improvement in the poor working conditions which existed, as part of the development programme.

Years of impoverishment and improvisation had resulted in the Department's engineering staff being left with " cramped, badly-lighted badly-ventilated and badly-heated buildings, out-dated equipment and decayed poles."

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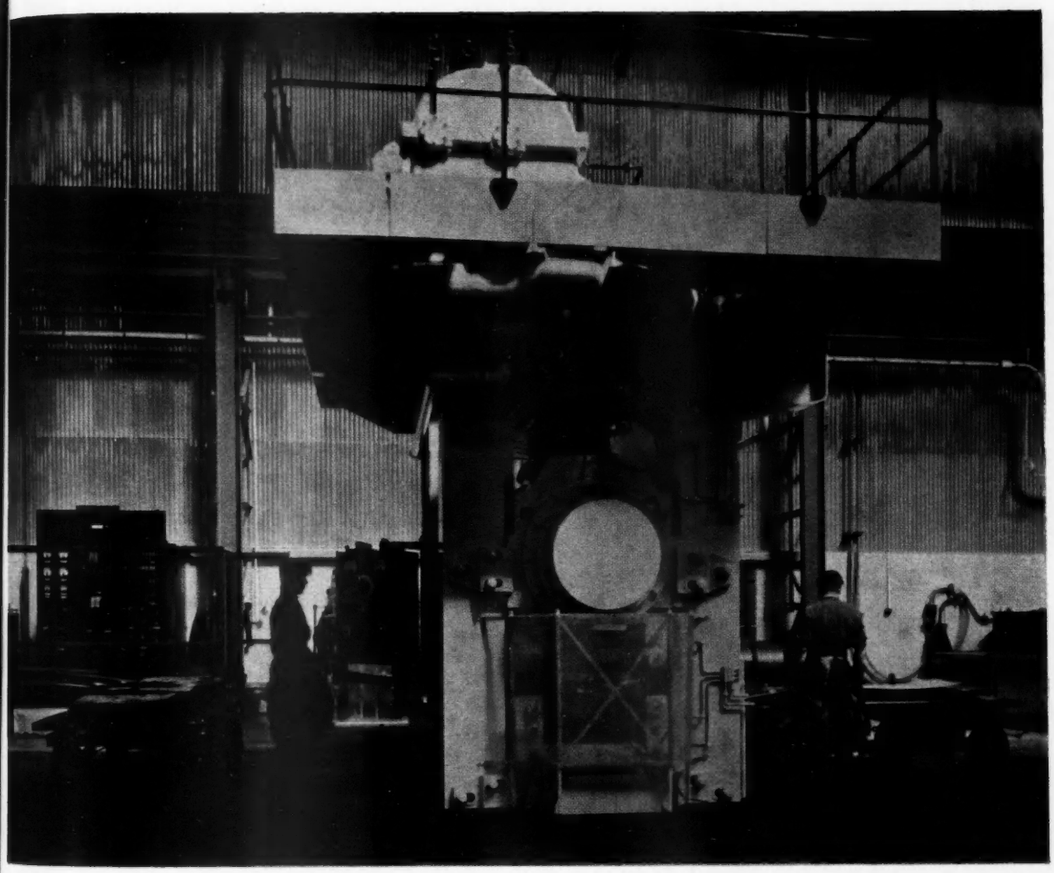

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The 32″ × 42″ 2-High 2-Stand Hot Roughing and Finishing Sheet Mill with the Finishing Stand in the foreground.

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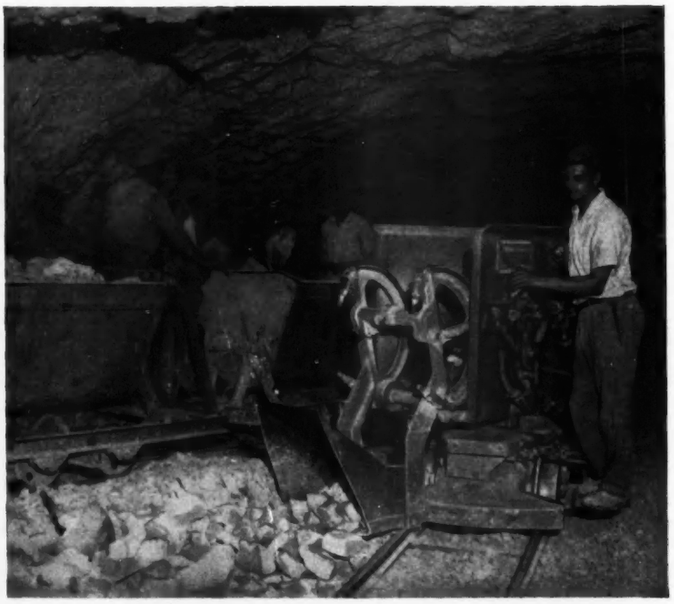
Obstacles were many for such a short road. Sharp gradients, steep walls and the necessity of blasting through poor rock formation—upper cretaceous limestone. Driving the tunnels, therefore, was in 5 successive steps: pilot tunnel, enlargement of the upper part, timbering and centering, drilling and blasting of central bottom heading and enlargement of side areas.



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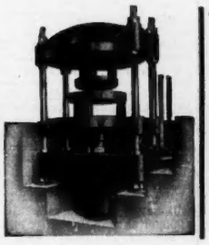

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(Sgd.) CHIEF ENGINEER. D 685

PUBLIC APPOINTMENTS.

BRITISH RAILWAYS, EASTERN REGION, have vacancies for a number of **ASSISTANTS** and **SENIOR ASSISTANTS** in the NEW WORKS SECTION of the CIVIL ENGINEERING DEPARTMENT, KING'S CROSS STATION, LONDON, N.1. Applications are invited from candidates with experience of structural and/or permanent way work, including design, preparation of drawings, estimates, Bills of Quantities and Contract Documents, surveying, levellings, etc. Salaries at ranges between £660 and £1000 per annum, according to qualifications and experience. Five-day week and travelling concessions.—Applications, quoting reference "Modernisation," giving particulars as to age, experience and qualifications (if any) should be addressed to the CHIEF CIVIL ENGINEER, EASTERN REGION, BRITISH RAILWAYS, KING'S CROSS STATION, LONDON, N.1. D 524

EXPERIENCED CIVIL ENGINEERING ASSISTANTS required for design of road networks in clearance areas, design of new roads and road improvements; supervision of construction contracts. Salaries according to qualifications and experience.—Apply personally or by letter to CHIEF ENGINEER (55/36), LONDON COUNTY COUNCIL, COUNTY HALL, S.E.1. (877.) D 542

UNIVERSITY OF EDINBURGH.

DEPARTMENT OF ENGINEERING.

APPLICATIONS are invited for a **LECTURESHIP IN ENGINEERING.** Salary Scale, £950 by £50 to £1350 per annum, with placement according to qualifications and experience, and with superannuation Benefit and Family Allowance where applicable. Applications must have had industrial and research experience. The teaching duties will be principally in the post-graduate school of Electronics and Radio. The successful candidate will be required to take up duty on 1st October, 1955, or as soon thereafter as possible.

Further particulars may be obtained from the undersigned, with whom applications, together with the names of two referees, should be lodged not later than 1st AUGUST, 1955.

CHARLES H. STEWART,
SECRETARY TO THE UNIVERSITY.
June, 1955. D 497

UNIVERSITY OF EDINBURGH.

DEPARTMENT OF ENGINEERING.

APPLICATIONS are invited for an **ASSISTANTSHIP IN ENGINEERING.** Salary Scale, £550 by £50 to £650 per annum, with superannuation benefit and family allowance where applicable. Candidates should possess an honours degree in Civil or Mechanical Engineering. Industrial or research experience is desirable. The successful candidate will be expected to take up duty on 1st October, 1955, or as soon thereafter as possible.

Further particulars may be obtained from the undersigned with whom applications, together with the names of two referees, should be lodged not later than 23rd JULY, 1955.

CHARLES H. STEWART,
SECRETARY TO THE UNIVERSITY.
June, 1955. D 498

CITY OF NOTTINGHAM.

(a) **ASSISTANT STRUCTURAL ENGINEER** (APT VI, £930-£1000 p.a.).

(b) **ASSISTANT ENGINEERS** (APT V, £750-£900 p.a.).

(c) **JUNIOR HEATING ENGINEER** (APT I to III, £500-£725 p.a.).

Applications are invited for the above positions in the City Engineer's Department, Nottingham. Particulars of the posts are:—

(a) The person appointed will be in charge of important bridge design work and should be experienced in design in steel, R.C. work and prestressed concrete, commencing salary in Grade APT VI is £930 p.a.

(b) Candidates should be experienced in the design of one of the following classes of work—sewage disposal works; main drainage; bridges; structural frames; highways.

(c) Candidates should be capable of working on heating schemes under supervision.

Commencing salaries for posts (b) and (c) will depend on experience.

HOUSING ACCOMMODATION is available.

Applications on forms to be obtained from R. M. FINCH, O.B.E., M.I.C.E., CITY ENGINEER, GUILDHALL, NOTTINGHAM, are to be returned to him by 30th JUNE, 1955. D 579

LONDON COUNTY COUNCIL.

WESTMINSTER TECHNICAL COLLEGE.
SEPTEMBER, 1955.

LECTURER FOR DEPARTMENT OF CIVIL ENGINEERING. Should be engineering graduates or members of a professional institution and prepared to teach Theory and Design of Structures, Soil Mechanics to Higher National Certificate Standard. Burnham salary scale £1001 to £1113.—Application forms from PRINCIPAL AT COLLEGE, VINCENT SQUARE, S.W.1, returnable by 9th JULY, 1955, (865). D 614

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY, ALDERMASTON, BERKS,

requires an

ENGINEER GRADE II

to be responsible for the efficient operation, maintenance, overhaul and replacement of mechanical engineering plant (particularly heating, ventilation and air extraction plant) and chemical plant (water purification and effluent treatment plant) installed in or associated with the safe operation of laboratories handling radioactive and other highly toxic materials. Applicants should have served a recognised engineering apprenticeship and should be either corporate members of one of the Institutions of Electrical or Mechanical Engineers or possess exempting qualifications. Previous experience of the operation of plant dealing with radioactive or toxic materials and of the associated hazards is desirable. They should be able to initiate and advise on the design of special equipment.

SALARY: £1065-£1370 per annum (male).

SUPERANNUATION: The successful applicant will be required to join the Authority's contributory scheme.

HOUSING: Housing accommodation will be available within a reasonable period for married officers who live outside the radius of the Establishment's transport facilities or alternatively the Authority may be able to assist successful applicants in the purchase of a house.

Requests for application forms by Post Card to SENIOR RECRUITMENT OFFICER, A.W.R.E., ALDERMASTON, BERKS. Quote Reference 675/WGE/26. D 673

ENGINEERING DRAUGHTSMEN AND WOMEN required for Civil and Mechanical engineering work. All positions pensionable. Salaries according to qualifications and experience.—Apply personally (Room 457) or by letter to CHIEF ENGINEER (55/38), LONDON COUNTY COUNCIL, COUNTY HALL, S.E.1 (891). G 553

ENGINEERS AND ENGINEERING ASSISTANTS required:—

CIVIL ENGINEERS AND CIVIL ENGINEERING ASSISTANTS.

(i) For design of large civil engineering works in connection with main drainage and sewage purification.

(ii) For road design and construction.

(iii) For design and detailing of engineering structures in concrete and steel.

STRUCTURAL ENGINEERS for detailing engineering structures in concrete and steel.

All positions pensionable with opportunities for the future. Salaries in accordance with qualifications and experience.—Apply personally (Room 457) or by letter to CHIEF ENGINEER (55/37), LONDON COUNTY COUNCIL, COUNTY HALL, S.E.1 (890). G 554

METROPOLITAN BOROUGH OF BATTERSEA.

BOROUGH ENGINEER AND SURVEYOR'S DEPARTMENT.

Applications are invited for the following appointments:—

(A) TWO SENIOR ASSISTANT ENGINEERS, GRADES APT. VI-VII, £825-£1100 plus London Weighting. Applicants should be Corporate Members of an appropriate Engineering Institution, and one successful candidate will be engaged primarily on Electrical and Mechanical Works and the other on structural works. Opportunities for other General Engineering Works will also occur.

(B) ONE ENGINEERING ASSISTANT, GRADE APT. II, £560-£640 plus London Weighting. Previous experience in local government service will be an advantage but is not essential. Commencing salaries will be according to qualifications and experience.—L. G. Superannuation Act.—Application forms from BOROUGH ENGINEER, TOWN HALL, S.W.11. CLOSING DATE 11th JULY. D 663

ELECTRICITY SUPPLY BOARD (DUBLIN).

Vacancies for

(A) ESTABLISHED AND (B) TEMPORARY CIVIL ENGINEERS.

The Electricity Supply Board has vacancies for (a) Established and (b) Temporary positions on its Civil Engineering Design Staff at its Head Office in Dublin.

Candidates should be not more than 35 years old and must possess a University degree in Civil Engineering or an equivalent qualification. They must have had at least five years experience on the design and construction of civil engineering work, the major portion of which experience should have been on the design of heavy reinforced concrete and/or structural steelwork. Design experience in the construction of steam power stations and/or hydro-electric works will be an advantage.

The salary scale applicable to these posts will be from £782 per annum to a maximum of £1061 per annum (inclusive of present cost-of-living bonus). The starting salary within this scale will depend on qualifications and the nature and extent of experience

The temporary appointments are expected to continue for at least three to five years (subject to satisfactory service), but those appointed will be eligible for consideration for appointment to the established staff if and when vacancies arise.

Applications setting out age and full details of qualifications and experience should be addressed to the PERSONNEL OFFICER, 27, LOWER FITZWILLIAM STREET, DUBLIN, so as to reach him not later than THURSDAY, 30th JUNE, 1955.

PATRICK J. DEMPSEY,
Secretary. D 619

AUSTRALIA—UNIVERSITY OF SYDNEY.

Applications are invited for the position of **SENIOR LECTURER IN CIVIL ENGINEERING.** Applicants should have specialised in Hydraulics; some experience of hydrological investigations would be an added qualification.

The salary scale is £A1800 per annum, rising by increments of £A70 to £A2150 per annum and salary is subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Finance is available for home purchase under Staff Members' Housing Scheme.

Further particulars and information as to the method of application may be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36, GORDON SQUARE, LONDON, W.C.1.

The closing date for the receipt of applications in Australia and London, is 9th JULY, 1955. D 616

CENTRAL ELECTRICITY AUTHORITY,
NORTH EASTERN DIVISION, require a **CHIEF ASSISTANT ENGINEER (MECHANICAL)** in the Generation (Construction) Department, at Divisional Headquarters, Newcastle-upon-Tyne.

Candidates should have received a first-class technical education and should preferably hold a recognised mechanical engineering degree or be a Corporate Member of one of the Professional Institutions. They should also have a wide practical knowledge of the design, layout, construction, and operation of generating stations.

Provisional salary: N.J.M. Scale 2, £1400-£1550 p.a.

Applications stating age, present position and salary, and giving full details of qualifications and experience to D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, LONDON, W.1, by 1st JULY, 1955. Quote Ref. ENG/598. D 617

ELECTRICITY SUPPLY BOARD, IRELAND

Vacancies for

TEMPORARY CIVIL ENGINEERS on site and survey work on the construction of power stations throughout the country.

GROUP A: **ENGINEERS** with at least five years experience on design and construction of engineering works. Salary scale £709 to £980 inclusive. Maximum age 35 years.

GROUP B: **JUNIOR ENGINEERS** with experience of surveying and/or construction of engineering works. Salary scale £9 9s. to £11 11s. per week inclusive.

Starting salary will depend on qualifications and experience.

Candidates must possess a recognised University Degree in Civil Engineering or equivalent. Appointments will probably continue for 2-3 years.

Successful candidates will be required to reside adjacent to site of work.

Applications, giving age and details of qualifications and experience and stating whether for Group A or B, should reach the PERSONNEL OFFICER, E.S.B., 27, LOWER FITZWILLIAM STREET, DUBLIN, not later than TUESDAY, 5th JULY, 1955.

PATRICK J. DEMPSEY,
Secretary. D 618

UNIVERSITY OF BELFAST.

The Senate of The Queen's University of Belfast invites applications for the following lectureships:

(1) TWO LECTURESHIPS IN ELECTRICAL ENGINEERING.

(2) ONE LECTURESHIP IN LIGHT ELECTRICAL ENGINEERING.

(3) THREE LECTURESHIPS IN MECHANICAL ENGINEERNG.

All from 1st OCTOBER, 1955.

Salary range £650 by £50 to £1000 and, on certain conditions being fulfilled, to £1350 plus contributory pension rights under the F.S.S.U. Initial placing may be at any point on the whole salary range but is dependent on qualifications and experience. Applications should be received by 30th JUNE, 1955.

Further particulars may be obtained from G. R. COWIE, M.A., LL.B., Secretary D 659

CORPORATION OF GLASGOW.

MUNICIPAL TRANSPORT DEPARTMENT.

WORK STUDY ENGINEER.

A Senior Work Study Engineer is required immediately by Glasgow Corporation Transport to take charge of the Work Study Department in a number of their vehicle maintenance works.

Applicants should have held a similar position in a modern engineering, or vehicle manufacturing concern for a minimum period of 12 months, and have experience of ratefixing methods based on work study.

The successful applicant, with a staff of ratefixers, will be engaged initially on the extension and administration of a bonus incentive scheme, introduced by consultants. Some knowledge of planning and production control principles is essential.

The position is permanent and superannuable with a starting salary, according to experience, in the range £750 to £815 per annum.—Applications stating age, qualifications and experience, together with one copy of two recent testimonials, should be submitted, within 14 days of publication of this advertisement, to the Subscriber.

E. R. L. FITZPAYNE,
General Manager.

46, Bath Street,
Glasgow, C.2.
9th June, 1955. D 662

LOUGHBOROUGH COLLEGE OF TECHNOLOGY.

Principal: H. L. HASLEGRAVE, Wh.Sc., M.A. (Cantab.), Ph.D.(Lond.), M.Sc.(Eng.), M.I.Mech.E., M.I.E.E., M.I.Prod.E.

DEPARTMENT OF INDUSTRIAL ENGINEERING.

Head of Department: J. FRANCE, M.I.Mech.E., M.I.Prod.E.

APPOINTMENT OF LECTURER IN PRIMARY FORMING PROCESSES.

Applications are invited for the post of Lecturer in Primary Forming Processes, comprising such subjects as Press and Sheet Metalwork, Welding Processes, and Foundry Technology.

The lecturer appointed must be capable of dealing with these subjects to an advanced stage. He should have had considerable industrial experience and, preferably, hold qualifications in Production Engineering and Metallurgy. Teaching experience will be an advantage.

Salary will be paid according to the scale for Lecturers of the Burnham Committee Award, 1954, namely, £965 by £25 to £1065.

Further particulars and application forms can be obtained from The Registrar. D 690

CITY OF LIVERPOOL.

CITY ENGINEER AND SURVEYOR'S DEPARTMENT.

Applications are invited for the appointment of **DESIGN ENGINEER (MECHANICAL).** Salary £650 by £25 to £775 per annum (N.J.C. Scale).

Applicants should be Graduate Members of the Institution of Mechanical Engineers or hold an equivalent qualification and have had a recognised practical training in general mechanical engineering, which must include at least 4 years' drawing office practice. Preference will be given to applicants with some specialised knowledge of centrifugal pumping machinery and associated electrical equipment. Some knowledge of automobile engineering and vehicle body design is also desirable.

Application forms, obtainable from the City Engineer and Surveyor, Municipal Buildings, Liverpool, 2, should be returned to him by 6th August, 1955.

The appointment is superannuable and subject to the Standing Orders of the City Council. Canvassing disqualifies.

THOMAS ALKER,
Town Clerk.

Municipal Buildings,
Liverpool, 2 (JA3975). D 654

BARROW-IN-FURNESS EDUCATION COMMITTEE.

CENTRAL COLLEGE OF FURTHER EDUCATION.

Required in September, 1955, a **FULL-TIME ASSISTANT, GRADE A TO TEACH MECHANICAL ENGINEERING** and allied subjects to Ordinary National Certificate level; ability to offer Mathematics and Strength of Materials to A1 level will be an advantage. Applicants should have had good industrial experience and should possess sound technological and/or graduate qualifications. Burnham Scale, viz. £450 by £18 to £725 with additions in respect of approved qualifications and training and for suitable industrial and teaching experience.—Application forms, obtainable by sending a stamped addressed foolscap envelope to the CHIEF EDUCATION OFFICER, JOHN WHINNERAH INSTITUTE, BARROW-IN-FURNESS, should be returned as soon as possible.

LAWRENCE ALLEN,
Town Clerk.

Town Hall,
Barrow-in-Furness. D 650

CITY OF NOTTINGHAM.

GRADUATE ASSISTANT ENGINEER (£560-£775 P.A.)

Applications are invited for the above position in the City Engineer's Department. Applicants should have (or be sitting for this summer) a University Degree or a Diploma giving exemption from the Institution of Civil Engineers examinations. The person appointed will be registered under the Training of Municipal Engineers Scheme and given experience of all branches of municipal engineering work as carried on in the City Engineer's Department.

Commencing salary is £560 per annum rising after two years' training to £650 and then by £25 per annum to £775.

Applications, on forms to be obtained from R. M. FINCH, O.B.E., M.I.C.E., CITY ENGINEER AND SURVEYOR, GUILDHALL, NOTTINGHAM, are to be returned not later than FRIDAY, 15th JULY, 1955. D 732

LONDON COUNTY COUNCIL.

WANDSWORTH TECHNICAL COLLEGE.
SEPTEMBER, 1955.

ASSISTANT GRADE A, to teach Sheet Metal Work Theory and Practice to Final City and Guilds standard. Appropriate qualifications, industrial and teaching experience desirable. Burnham Salary Scale varies between £486 and £917. Individual minimum and maximum according to age, qualifications and experience.—Application forms from SECRETARY AT COLLEGE, WANDSWORTH HIGH STREET, S.W.18, returnable by 9th JULY, 1955 (930). D 649

ESSEX EDUCATION COMMITTEE.

SOUTH-WEST ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART,
FOREST ROAD, WALTHAMSTOW, E.17.

Required as soon as possible
ASSISTANT, GRADE B, TO TEACH ENGINEERING SCIENCE AND ENGINEERING DRAWING to S3 standard and, if possible, Strength of Materials or Theory of Machines to A1 and A2 standard. Candidates should be graduates, or possess equivalent qualifications. Some teaching experience either in mechanical or production engineering and/or industrial experience would be an advantage.

Salary scale £525 by £25 to £820 per annum plus London Allowance, with additions for graduation and training, and increments for previous teaching service, war service and approved industrial experience.

Applications, with full details of training, qualifications and experience, to THE CLERK TO THE GOVERNORS AT THE COLLEGE. D 644

CITY OF BATH EDUCATION COMMITTEE.

CITY OF BATH TECHNICAL COLLEGE.

Principal: A. H. YATES, B.Sc., B.Sc.(Eng.), A.F.R.Ae.S.

DEPARTMENT OF ENGINEERING AND SCIENCE.

Required for September, 1955, a **FULL-TIME ASSISTANT TEACHER FOR ELECTRICAL SUBJECTS** with special reference to Electrical Installation Work.

Good technical qualification and industrial experience required.

Burnham Scale (Grade A) £450 by £18 to £725. The starting point on the scale depends on previous experience.

Forms of application (to be returned immediately) and full particulars from the PRINCIPAL, LOWER BOROUGH WALLS, BATH.

H. W. BRAND,
Director of Education.

Guildhall,
Bath. D 658

UNIVERSITY OF TASMANIA AND HOBART TECHNICAL COLLEGE.

LECTURESHIP IN CIVIL ENGINEERING.

Applications are invited from graduates in Civil Engineering (preferably with Honours) for the above position.

The successful applicant will be required to assist in the teaching of Civil Engineering subjects of University Degree and Technical College Diploma Courses in fields in which he is specially qualified, and will be given the opportunity for research.

Salary according to qualifications and experience will be within the range £900 to £1500 per annum inclusive of cost-of-living allowance. Salary scales are at present being reviewed and range shown may be subject to increase.

Full particulars may be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36, GORDON SQUARE, LONDON, W.C.1, or from the undersigned.

Closing date for applications is 10th OCTOBER, 1955.

JOHN H. M. OMOND,
Secretary,
Engineering Board of Management.

BOX 197E, G.P.O.,
Hobart,
TASMANIA. D 753

CUMBERLAND EDUCATION COMMITTEE.
WORKINGTON COLLEGE OF FURTHER EDUCATION.

Principal: J. FARMERY, B.Sc.(Eng.), M.I.E.E., M.I.Mech.E., M.I.P.E.

Applications are invited for the post of **ASSISTANT, GRADE "B," IN THE DEPARTMENT OF ENGINEERING AND METALLURGY,** to teach subjects up to Higher National Certificate standard in Mechanical Engineering. Candidates able to offer Applied Heat up to Ordinary National Certificate, and Machines up to Higher National Certificate level, would have an additional recommendation. Candidates should possess a good Degree in Engineering, or equivalent qualification, and must have had suitable industrial experience. The salary scale is that of the Burnham Technical, Grade "B," viz. £525 by £25 to £820, with additions for appropriate training and/or Honours Degree. The College is within easy reach of the Lake District, in a rapidly expanding industrial area, and the post offers considerable scope to the right man.—Application forms and further particulars are obtainable from THE REGISTRAR, WORKINGTON COLLEGE OF FURTHER EDUCATION, PARK LANE, WORKINGTON, and, when completed, should be returned to the PRINCIPAL within fourteen days.

GORDON S. BESSEY,
Director of Education.

5, Portland Square,
Carlisle. D 627

SOUTHAMPTON CORPORATION WATERWORKS.

APPOINTMENT OF ASSISTANT STATION SUPERINTENDENT.

ASSISTANT STATION SUPERINTENDENT for River Itchen Pumping Station, Otterbourne, near Winchester. Appointment Miscellaneous Grade V. Total remuneration £560-£820, which includes value of house on works. Full apprenticeship (fitting and training) and knowledge of Diesel and Electric Plant essential. Previous experience in Waterworks advantageous.—Application Form and Conditions from JOSEPH HAWKESLEY, M.I.Mech.E., WATERWORKS ENGINEER, CIVIC CENTRE, SOUTHAMPTON. Applications by WEDNESDAY, 13th JULY, 1955. D 733

THE COLLEGE OF AERONAUTICS.

DESIGN DRAUGHTSMAN required for work on special plant and equipment associated with aeronautical research and development work. Previous experience and electrical knowledge an advantage but not essential. H.N.C. or equivalent preferred. Five-day week. Four weeks' leave a year, excluding Bank Holidays. Salary range £650-£750 per annum depending on age, qualifications and experience.—Application forms from CHIEF CLERK, THE COLLEGE OF AERONAUTICS, CRANFIELD, BLETCHLEY, BUCKS. D 726

HER MAJESTY'S OVERSEA CIVIL SERVICE.

Applications are invited for the following posts:—
ASSISTANT EXECUTIVE ENGINEERS,
SARAWAK.

Vacancies exist for Assistant Engineers in the Public Works Department, Sarawak, for General Civil and Public Works Engineering.

Appointment is to the permanent and pensionable establishment on probation for three years in the first instance. Salary in the incremental scale £798-£1512 per annum plus expatriation pay and a non-pensionable cost-of-living allowance.; £60 outfit allowance. Free passages for officer and wife and up to three children. Generous home leave. Certain free medical attention.

Candidates should possess a University degree or diploma recognised as giving exemption from the Final Parts I and II of the Institution of Civil Engineers examination or be A.M.I.C.E.

Full details on application to the DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, SANCTUARY BUILDINGS, GREAT SMITH STREET, LONDON, S.W.1, giving brief details of age, qualifications and experience. Quote reference BCD/112/24/01/D5. D 723

BRITISH TRANSPORT COMMISSION, BRITISH TRANSPORT WATERWAYS, 22, DORSET SQUARE, LONDON, N.W.1, invite applications for the appointment of
SENIOR ENGINEERING ASSISTANT (MECHANICAL AND ELECTRICAL), Divisional Engineer's Office, South Western Waterways Division, Gloucester. Salary range £900-£1100.

Applicants should be Associate Members of the Institution of Electrical Engineers with mechanical experience, or of the Institution of Mechanical Engineers with considerable up-to-date electrical experience.

The selected candidate will be required to join, if eligible, a contributory Superannuation Scheme of the Commission.—Applications, stating age, experience and qualifications, should be sent to the STAFF AND ESTABLISHMENT OFFICER, at the above address not later than 30th JUNE, 1955. D 728

CENTRAL ELECTRICITY AUTHORITY.

SENIOR CIVIL ENGINEER,
CHIEF ENGINEER'S DEPARTMENT,
HEADQUARTERS.

Applications are invited for the appointment of a **SENIOR CIVIL ENGINEER** in the Chief Engineer's Department at Headquarters in London.

The salary for the appointment, which is superannuable, will be within the range £2400-£2900 per annum.

Candidates should be corporate members of the Institution of Civil Engineers and have wide experience in the design and construction of large civil engineering works, preferably associated with thermal generating stations and hydro-electric projects.

Duties will include the critical examination of civil engineering problems involved in the construction of new and extension of existing generating stations.

Applications, stating age, qualifications, experience, present position and salary, to be forwarded to D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, W.1, to be received not later than 8th JULY, 1955. Quote AE/610. D 703

HER MAJESTY'S OVERSEA CIVIL SERVICE.

Applications are invited for the following post:—
SENIOR EXECUTIVE ENGINEER (ROADS),
NIGERIA.

A vacancy exists for a Senior Executive Engineer (Roads) in the Public Works Department in the Western Region of Nigeria to administer and exercise general supervision over a large-scale programme of road development and improvement.

Appointment on contract/gratuity terms with gross emoluments of £2150 p.a. plus substantial gratuity on satisfactory completion of contract; £60 outfit allowance; free first-class passages for officer and wife and assistance for children. Generous home leave.

Candidates should be Corporate Members of the Institution of Civil Engineers and have had not less than 10 years' experience in road construction and bituminous surfacing works; supervision of major contracts for road works and control of staff.

Full details on application to THE DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, SANCTUARY BUILDINGS, GREAT SMITH STREET, LONDON, S.W.1, giving brief details of age, qualifications and experience. Quote reference BCD 112/410/013/D5 NIGERIA. D 722

ELECTRIC
melting and smelting
PRACTICE

A. G. E. Robiette, M.Sc.

In recent years the design of electric furnaces has made considerable progress, and they are being applied in a rapidly expanding field of metallurgical practice. Mr. Robiette's great experience of electric melting and smelting plants is unrivalled, for he has studied their operation and advised upon their design in all parts of the world. His authoritative new book has just been published at 50*s.* net.

(Postage 1*s.* 6*d.*)

CHARLES GRIFFIN & COMPANY, LTD.

42 DRURY LANE, LONDON, W.C.2

Classified Advertisements continued on Page 4

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE.

Principal: H. BAKER, Ph.D., A.M.I.C.E., A.M.I.Mech.E.

Applications are invited for the post of **ASSISTANT LECTURER, GRADE B,** in the Department of **MECHANICAL ENGINEERING.** Preference will be shown to applicants having an Engineering Degree and/or Corporate Membership of the Institution of Mechanical Engineers. Previous teaching experience will be an added recommendation. The successful candidate will be required to teach some of the following subjects to H.N.C. or Degree standard: Strength of Materials, Theory of Machines, Applied Thermodynamics, Mechanics of Fluids.

Salary: £525 by £25 to £820 per annum, together with degree and training allowances in appropriate cases.

Application forms and further particulars may be obtained from THE REGISTRAR, NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE, SHAKESPEARE STREET, NOTTINGHAM, to whom completed forms should be returned not later than 8th JULY, 1955.

F. STEPHENSON,
Clerk to the Joint Education Committee.
D 717

WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH, NIGERIA.

Applications are invited for the post of **RESEARCH ENGINEER,** at the WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH.

Duties are primarily research and development in connection with engineering problems, particularly those arising in the processing of oil palm fruit in plantation oil mills of various kinds. The officer will be required to work in close collaboration with other members of the Institute staff concerned with the production of the crop in the field and will be required to modify existing plant or design new.

Appointment is either pensionable or on contract in the gross salary range £1172 10s. to £2037 10s. p.a. with a gratuity of £122 to £275 10s. p.a. in the case of a contract appointment.

Free passages are provided for the officer, his wife and all children under 13 years of age. Furnished Government quarters are provided if available at a rental of 10 per cent. basic salary subject to a maximum of £150 per annum. Leave is granted at the rate of 7 days for each completed month of resident service.

Candidates, not less than 26 years of age, should hold a good honours degree in Mechanical or Chemical Engineering, and have had at least 3 years post-graduate experience in the design and operation of plant for vegetable oil extraction and processing. They must possess a "research outlook" and should be well versed in the critical appreciation of practical problems from a scientific angle. They must be well qualified engineers with a particular aptitude for mechanical matters, and have a good knowledge and experience of chemistry.

Apply, in writing, to the DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, GREAT SMITH STREET, LONDON, S.W.1, giving briefly age, qualifications and experience. Mention the reference number BCD 197/199/0/-. D 721

EUROPEAN COUNCIL FOR NUCLEAR RESEARCH, GENEVA, has a number of vacancies for **RESEARCH PHYSICISTS, ELECTRICAL, ELECTRONIC AND MECHANICAL ENGINEERS** to assist in the design and construction of high energy accelerating machines for nuclear research. The posts, in varying grades, carry salaries ranging from 10,200 to 20,100 Swiss francs tax free per annum.

First class qualifications and experience essential. For further information and application forms write to the SECRETARY, MINISTRY OF LABOUR AND NATIONAL SERVICE, ALMACK HOUSE, 26, KING STREET, LONDON, S.W.1, quoting A12/179/CERN. D 724

EXPERIMENTAL OFFICERS AND ASSISTANT EXPERIMENTAL OFFICERS in various Government Departments. The CIVIL SERVICE COMMISSIONERS invite applications for pensionable posts. Applications may be accepted up to 31st December, 1955, but forms should be returned as soon as possible as an earlier closing date may be announced either for the competition as a whole or in one or more subjects. No more applications from meteorologists can be accepted. Interview Boards will sit at frequent intervals.

The posts are divided between following main groups and subjects: (*a*) Mathematical and Physical Sciences, (*b*) Chemistry and Metallurgy, (*c*) Biological Sciences, (*d*) Engineering subjects, and (*e*) Miscellaneous (including, e.g. Geology, Library and Technical Information Services).

AGE LIMITS: For Experimental Officers, at least 26 and under 31 on 31st December, 1955; for Assistant Experimental Officers at least 18 and under 28 on 31st December, 1955. Extension for regular service in H.M. Forces. Candidates aged 31 or over with specialised experience for Experimental Officer posts may be admitted.

Candidates must have at least one of a number of specified qualifications. Examples are Higher School Certificate, General Certificate of Education, Scottish Leaving Certificate, Scottish Universities Preliminary Examination, Northern Ireland Senior Certificate (all in appropriate subjects and at appropriate levels), Higher National Certificate, University degree. Candidates taking their examinations in 1955 may be admitted. Candidates without such qualifications may be admitted exceptionally on evidence of suitable experience. In general, a higher standard of qualification will be looked for in the older candidates than in the younger ones.

Salary (London): Experimental Officer £750-£920 (men); £663-£808 (women).

Assistant Experimental Officer £302 (at age 18) to £670 (men); £584 (women). Starting pay up to £545 (men) or £516 (women) at 26. Somewhat lower outside London. Promotion prospects. Women's scales subject to improvement under equal pay scheme.

Further particulars from CIVIL SERVICE COMMISSION, SCIENTIFIC BRANCH, 30, OLD BURLINGTON STREET, LONDON, W.1, quoting No. S94-95/55. D 691

SENIOR SCIENTIFIC OFFICERS; SCIENTIFIC OFFICERS. THE CIVIL SERVICE COMMISSIONERS invite applications for pensionable appointments. Applications may be accepted up to 31st December, 1955, but early application is advised as an earlier closing date may be announced. Interview Boards will sit at frequent intervals. The Scientific posts cover a wide range of scientific research and development in most of the major fields of fundamental and applied science. In biological subjects the number of vacancies is small; individual vacancies exist for candidates who have special knowledge of, or who are interested in palaeobotany, foraminifera, and recent and pleistocene mammals.

Candidates must have obtained a university degree with first or second class honours in an appropriate scientific subject (including engineering) or in Mathematics, or an equivalent qualification; or possess high professional attainments. Candidates for Senior Scientific Officer posts must in addition have had at least three years' post-graduate or other approved experience.

Candidates taking their degrees in 1955 may apply before the result of their degree examination is known.

AGE LIMITS: Senior Scientific Officers, between 26 and 31, but specially suitable candidates under 26 may be admitted. For Scientific Officers between 21 and 28 during 1955 (up to 31 for permanent members of the Experimental Officer class). Salary (London) Senior Scientific Officers: (men) £1010-£1185; (women) £893-£1077. Scientific Officers: (men) £492-£885; (women) £492-£795. Women's scales subject to improvement under equal pay scheme. Somewhat lower rates in the provinces.

Further particulars from CIVIL SERVICE COMMISSION, SCIENTIFIC BRANCH, 30, OLD BURLINGTON STREET, LONDON, W.1, quoting No. S.53/55 for Senior Scientific Officers and S.52/55 for Scientific Officers. D 692

MIDDLESBROUGH EDUCATION COMMITTEE.

CONSTANTINE TECHNICAL COLLEGE.

Applications are invited for the appointment of **LECTURER** in the Department of Structural Engineering, commencing as soon as possible, to teach Design and Theory of Structures to Higher National Diploma standard. Ability to teach one or more of Surveying, Mechanics of Fluids, Geology and Soil Mechanics is desirable. Salary £965 by £25 to £1065.

Forms and particulars are obtainable from DIRECTOR OF EDUCATION, WOODLANDS ROAD, MIDDLESBROUGH, to whom applications should be returned by FRIDAY, 1st JULY, 1955. D 677

NORTH GLOUCESTERSHIRE TECHNICAL COLLEGE, CHELTENHAM.

Applications are invited from suitably qualified persons for the post of **ASSISTANT LECTURER (GRADE B),** to take Mechanical Engineering subjects to Ordinary and Higher National Certificate level.

Salary scale £525 per annum rising to £820 per annum plus allowances for Degree and/or recognised training. In fixing the commencing salary recognition will be given for approved industrial experience over the age of 21.

Forms of application which can be obtained from the CLERK TO THE GOVERNORS should be returned to him within ten days of the appearance of this advertisement. D 701

SOUTH AFRICAN BUREAU OF STANDARDS.

VACANCY: METALLURGIST.

Applications are invited from suitably qualified persons for appointment as **METALLURGIST.** Applicants should hold at least a B.Sc. degree with Chemistry and/or Metallurgy as a major subject or an equivalent qualification. Experience in metallurgical analysis and a knowledge of the metallurgy of iron and steel will be a recommendation.

The salary scale is £1020 by £60 to £1380 plus a cost-of-living allowance of £234 per annum in the case of married officers.

It is obligatory to become a member of the Provident Fund which involves a contribution of 7 per cent. of basic salary, and a similar contribution by the Council of the South African Bureau of Standards.

The successful applicant will be appointed on a contract basis for three years and will be paid full salary as from the date of embarkation, plus cost of rail and second class boat fares for himself and immediate family. Should the successful applicant terminate his contract within a period less than three years he will be required to refund a pro rata proportion of the expenses incurred in bringing him and his family to South Africa. After the expiry of the three years contract period the successful applicant will be on the Bureau's staff subject to the normal conditions of employment. In addition, the successful applicant will after three months' service with the Bureau also be entitled to claim a refund of 50 per cent. or £60 whichever is the lesser (in the case of married officers) or 50 per cent. or £20 whichever is the lesser (in the case of single officers) of the cost of transporting his furniture and personal effects to Pretoria, such claim to be properly substantiated by receipts.

Applications giving full details regarding age, marital status, nationality, knowledge of English, Scientific and Technical qualifications and experience, together with a medical certificate of health and the names of at least two persons to whom reference may be made, must reach THE SECRETARY, SOUTH AFRICAN BUREAU OF STANDARDS, PRIVATE BAG 191, PRETORIA, SOUTH AFRICA, before 15th AUGUST, 1955. D 693

TECHNICAL ASSISTANT required in Chief Civil Engineer's Office, Eastern Region, British Railways, Kings Cross. Salary range £660-£750 according to experience and qualifications. Applicants should have had experience in steel and reinforced concrete design and detailing, including taking off quantities. A knowledge of permanent way work would be an advantage. Five-day week, permanency to suitable applicant and concessionary rail travel.—Applications giving details as to age, experience and qualifications, quoting reference 1310, should be addressed to the CHIEF CIVIL ENGINEER, EASTERN REGION, BRITISH RAILWAYS, KINGS CROSS STATION, LONDON, N.1. D 621

DEPARTMENT OF THE CHIEF ENGINEER AND COUNTY SURVEYOR.

Required:—

(A) ASSISTANT DIVISIONAL ENGINEER, £1350 by £50 to £1550 by £75 to £1700.

(B) ASSISTANT SENIOR ENGINEER, £1275 by £63 15s. to £1530.

Candidates should be corporate members of the Institution of Civil Engineers or hold other approved qualifications. The duties of appointment (A) will include deputising for the Divisional Engineer as required.

For both positions experience in the design and execution of major street improvements, the engineering aspects of town planning, Parliamentary Bills, attendance at Committees and negotiations with Government Departments and public authorities is desirable.

The positions are permanent and pensionable.

Applications must be submitted by 18th JULY, 1955, on the prescribed form obtainable together with full particulars from the CLERK OF THE COUNCIL (CL/F2), THE COUNTY HALL, S.E.1. (986) D 755

NATIONAL COAL BOARD invite applications for superannuable appointments as **SPECIALIST ENGINEERS** in the Civil Engineering Section of Production Engineering Branch at London Headquarters. Candidates should have a degree in Civil Engineering, or be graduate members of the Institute of Civil Engineers or of the Institute of Structural Engineers with adequate civil engineering experience. In addition they should have had at least 2 years experience in an engineering design office on works involving structural steelwork or concrete construction. Some site experience would be an advantage. Salary depending upon qualifications and experience will be within the range £500-£1000 per annum, but not less than £650 at the age of 25.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates) to NATIONAL COAL BOARD, ESTABLISHMENTS (PERSONNEL), HOBART HOUSE, GROSVENOR PLACE, LONDON, S.W.1, marking envelope SS/17. Original testimonials should NOT be forwarded. Closing date 18th JULY, 1955. D 742

NATIONAL COAL BOARD invite applications for a superannuable appointment as **ELECTRICAL INSTRUCTOR** at the Mines Mechanisation Training Centre, West Bar, Sheffield. Candidates should have a thorough knowledge of the design, installation, repair and operation of all types of surface and underground electrical equipment. Teaching experience and a Higher National Certificate (Electrical) would be an advantage. Salary range £591 10s.-£691 10s.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates) to NATIONAL COAL BOARD, ESTABLISHMENTS (PERSONNEL), HOBART HOUSE, GROSVENOR PLACE, LONDON, S.W.1, marking envelope SS/18. Original testimonials should NOT be forwarded. Closing date 5th JULY, 1955. D 743

CENTRAL ELECTRICITY AUTHORITY. YORKSHIRE DIVISION.

Applications are invited for the following appointments at Wakefield "B" Power Station. The station will have an ultimate capacity of 240 MW.

DEPUTY STATION SUPERINTENDENT

Salary £1110-£1200 per annum, Class H, Grade 3, National Joint Board Agreement.

Applicants should have had a wide experience in the administration and operation of a large modern power station and should preferably be Corporate Members of the Institution of Mechanical Engineers and/or Electrical Engineers, or hold equivalent qualifications.

MAINTENANCE ENGINEER (MECHANICAL)

Salary £900-£975 per annum, Class H, Grade 6, National Joint Board Agreement.

Applicants should have had wide experience in the maintenance and administration of a large modern power station. Possession of recognised technical qualifications in Mechanical Engineering would be an advantage.

SHIFT CHARGE ENGINEERS

Salary £840-£900 per annum, Class H, Grade 7, National Joint Board Agreement.

Applicants should have operating experience with large-capacity high-pressure Turbo-Alternators and Boilers, and should preferably possess technical qualifications admitting to Corporate Membership of the Institution of Mechanical Engineers and/or Institution of Electrical Engineers.

STATION SHIFT CONTROL ENGINEERS

Salary £715-£760 per annum, Class H, Grade 10, National Joint Board Agreement.

Applicants should have had a sound training and practical experience in a modern power station control room. The possession of recognised technical qualifications in Electrical Engineering would be an advantage.

GENERAL ASSISTANT ENGINEERS

Salary £475-£520 per annum, Class H, Grade 16, National Joint Board Agreement.

Preference will be given to candidates possessing recognised technical qualifications or who are at present following a course of study with the object of obtaining such qualifications.

Housing accommodation may be available.

Application forms obtainable from DIVISIONAL SECRETARY (ESTABLISHMENTS), CENTRAL ELECTRICITY HOUSE, ST. MARY'S ROAD, LEEDS, 7, to be returned within 14 days of the appearance of this advertisement.

G. A. VOWLES,
Divisional Controller D 754

TECHNICAL ASSISTANT required by BRITISH RAILWAYS IN BRIDGE SECTION DRAWING OFFICE AT KINGS CROSS. Applicant should have had experience in one of the following: Design of Welded and Riveted Steelwork; Abutment and Foundation Work; Prestressed Concrete. Able to prepare detailed drawings, calculations, surveys and estimates in connection with bridge design. Salary range £660-£750. Five-day week, concessionary rail travel, permanency to suitable applicant and opportunities for progressing.—Apply in writing giving particulars as to age, experience, and qualification, quoting reference 1445, to CHIEF CIVIL ENGINEER, BRITISH RAILWAYS, KINGS CROSS STATION, LONDON, N.1. D 622

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LECTURER required to teach Mechanical Engineering subjects up to the standard of the Higher National Certificate and the External London B.Sc. Degree. Applicants should have an honours degree in mechanical engineering or an equivalent qualification. Both industrial and teaching experience are required.

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Salaries for both posts according to the Burnham Technical Scale, 1954.

Further particulars and application forms obtainable from W. R. SMEDLEY, CHIEF EDUCATION OFFICER, TOWN HALL, BOURNEMOUTH, returnable by 8th JULY. D 739

APPOINTMENTS OPEN.

THE ENGAGEMENT OF PERSONS answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

It is advisable when sending testimonials to forward copies and NOT originals.

RUSTON-BUCYRUS, LTD., EXCAVATOR MANUFACTURERS, LINCOLN, have a vacancy in their U.K. Sales Organisation for an **ENGINEER BETWEEN 25 AND 30 YEARS** of age.

Applicants must be of first-class education, with recognised Mechanical or Civil Engineering qualifications. Some experience in the use and application of Civil Engineering Construction equipment would be favoured, but comprehensive training will be given to the successful applicant.

A permanent position with excellent opportunities is offered in an attractive sphere of employment.

Write, giving age and full details of education, qualifications and experience, to PERSONNEL MANAGER. D 398

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ENGINEER with knowledge of the theory and design of precision hydraulic mechanisms. Applications stating age, qualifications, and experience to be addressed to THE SECRETARY, BARR AND STROUD, LIMITED, ANNIESLAND, GLASGOW, W.3, quoting ref. 769/T-15. D 457

A large firm of Reinforced Concrete Engineers in Rhodesia and the Union of South Africa has vacancies for

REINFORCED CONCRETE DESIGNERS AND DETAILERS with experience.—Apply in writing with full details of qualifications and experience, age and salary required to BOX B4/4/55, c/o 95, BISHOPSGATE, E.C.2. G 536

DRAUGHTSMEN.

APPLICATIONS ARE INVITED for the following appointments at the CLAYDON, SUFFOLK, works of THE BRITISH STEEL PILING CO., LTD.

STRUCTURAL DESIGNER DRAUGHTSMAN
(Minimum qualifications H.N.C. or equivalent.)

MECHANICAL DESIGNER DRAUGHTSMEN
(Minimum qualifications H.N.C. or equivalent.)
One of these vacancies is open to a suitably qualified candidate for work on Research and Development.

JUNIOR MECHANICAL DRAUGHTSMAN.
(Minimum qualifications O.N.C.)

Experience should preferably (but not essentially) include equipment such as cranes, hoisting machinery (steam, diesel, electric), mechanical-handling equipment, contractors' plant.

THESE ARE PROGRESSIVE PERMANENT POSITIONS IN AN EXPANDING ORGANISATION and candidates for the senior posts should be capable of accepting responsibility for complete projects.

The Company operates a contributory pension scheme and good canteen facilities exist.

Salary will be in accordance with age, qualifications and experience.

Applications in first instance to Works Manager at the above address. D 508

CIVIL ENGINEERING ASSISTANTS required by HEAD, WRIGHTSON & CO., LTD., for office work in the preparation of design drawings and contract documents for the construction of reinforced concrete foundations, structures and buildings for heavy industrial installations. Excellent working conditions; five-day week; pension scheme.—Applications stating age, qualifications and salary required to PERSONNEL MANAGER, REF. MK/8, TEESDALE IRON WORKS, THORNABY-ON-TEES. D 735

Belgian consulting engineers invite application for vacancies in their Brussels and Baghdad offices for two qualified engineers.

For BRUSSELS Office

ONE ELECTRICAL ENGINEER for planning and design of transmission lines and distribution stations including drawing up of specifications and contract documents.

For BAGHDAD Office

ONE ELECTRICAL ENGINEER, preferably also with mechanical engineering qualifications; duties as for Brussels but will also be engaged in construction of steam power stations.

QUALIFICATIONS: **UNIVERSITY DEGREE OR EQUIVALENT AND/OR MEMBERSHIP OF PROFESSIONAL INSTITUTION,** coupled with practical experience.

For both posts a knowledge of the appropriate British Standards is required.

Perfect knowledge of English language essential, knowledge of French desirable. Appointments will be in the first instance for 3 years with possibility of extension.

Applications, giving full details of qualifications and experience, should be addressed to the SOCIÉTÉ DE TRACTION ET D'ÉLECTRICITÉ, 31, RUE DE LA SCIENCE, BRUSSELS, BELGIUM. D 678

MECHANICAL ENGINEERING DRAUGHTSMAN required by large petroleum organisation for London head office. Experience in oil refinery and/or chemical plant work desirable but not essential. Salary according to age and experience. Good canteen facilities. Pension fund. Write stating age, qualifications and full details of experience to BOX Z.V.651, DEACON'S ADVERTISING, 36, LEADENHALL STREET, LONDON, E.C.3. G 527

JOHN BOOTH & SONS (BOLTON), LTD., invite applications for the post of **CHIEF DRAUGHTSMAN.** Applicants should be corporate members of the Institution of Structural Engineers and/or of the Institution of Civil Engineers and be fully qualified to take charge of the designing and detailing of riveted and welded steelwork for bridges, buildings and industrial plant. Age, particulars of experience and salary required should be stated when applying to THE DIRECTORS JOHN BOOTH & SONS (BOLTON), LTD., Hulton Steelworks Bolton. G 507

PETER BROTHERHOOD, LTD., Peterborough, require **DRAUGHTSMEN (SENIOR AND JUNIOR)** preferably with experience in design of compressors, turbines and steam engines. Permanent positions, five-day week, staff pension scheme.—Write giving full details age, experience and salary required. Z 426

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(*c*) Reinforced Concrete Bunkers and Foundations.
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SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN required for interesting work on large chemical plant installations. Experience in this type of work is desirable but not essential: applicants with general mechanical engineering experience will be favourably considered. The posts offer excellent opportunities with generous salaries commensurate with experience and ability. Offices situated in the N.W.1 London area. Five-day week and superannuation scheme.—Applications, which will be treated in confidence, should give previous experience and qualifications and be addressed to the CHIEF DRAUGHTSMAN, LAPORTE CHEMICALS, LIMITED, CLIFTON HOUSE, EUSTON ROAD, LONDON, N.W.1. G 542

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(*b*) Flight simulator assessment of aircraft stability.
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Previous experience in the aerodynamics or flight test department of aircraft or guided weapons industry desirable but not essential.

(*d*) Testing and development of electro-hydraulic servomechanisms.

Previous experience with hydraulics not essential. Good electrical knowledge is necessary. Duties will include testing equipment at hydraulic firms.

Please apply giving full details of career and salary required (which will be treated in strict confidence) to: PERSONNEL OFFICER, LOUIS NEWMARK LTD., PREFECT WORKS, PURLEY WAY, CROYDON, SURREY. D 759

DESIGN ENGINEERS AND DRAUGHTSMEN are required by THE METAL BOX CO., at their Technical Engineering Division located in the North Acton area. Work is in connection with process and plant development and offers scope to men with progressive ideas.—Apply in writing with full particulars of experience to THE PERSONNEL OFFICER, THE METAL BOX CO. LTD. (TECHNICAL ENGINEERING DIVISION), CHANDOS ROAD, LONDON, N.W.10. G 539

BRITISH CELLOPHANE LIMITED, BRIDGWATER, SOMERSET, seeks **SENIOR AND JUNIOR DRAUGHTSMEN,** for both PERMANENT and TEMPORARY appointments, for work on machine design and chemical plant layout. Applicants should possess at least O.N.C. and have had three years' shop experience. Five-day week, Pensions fund scheme for permanent appointments.

The TEMPORARY appointments are for a period of approximately two years' duration, subject to three months' notice and include generous subsistence allowances, and periodic home return rail fares.

ASSISTANT ENGINEERS, age 23/30 (permanent), also required. Applicants should have an honours degree in Mechanical Engineering and have had some practical works experience. The duties will be on development, improvement and maintenance of chemical and other plant.

Write to the PERSONNEL OFFICER, stating full particulars and salary required, and quote Ref. No. E.30 EG. D 342

DESIGNER/DRAUGHTSMAN required for London H.O. of a Firm of Reinforced Concrete Engineers and Contractors. Applicants should be qualified and possess experience of Building Frame design and knowledge of precast and prestressed concrete construction. The post is permanent and pensionable. Two weeks holiday allowed this year. Salary according to qualifications and experience.—Write full particulars to BOX G 547, Offices of ENGINEERING.

SECTION LEADER MECHANICAL DRAUGHTSMEN and competent Detailers required by ASHMORE, BENSON, PEASE & CO., STOCKTON-ON-TEES. Experience in layout and design of Gas, Chemical and similar plants an advantage, but sound knowledge of mechanical design essential. Company's flat, pension scheme, technical library and sports facilities available.—Apply stating age, experience, etc., quoting reference "L" to STAFF PERSONNEL OFFICER. G 518

REINFORCED CONCRETE DESIGNERS, DETAILERS wanted by BRITISH COMPANY IN MOMBASA (KENYA), KAMPALA (UGANDA), and DAR-ES-SALAAM (TANGANYIKA). Candidates should have had at least five years' experience. Salary according to ability and experience. Free air passages, two months' paid home leave by air each 2½ years, bonus and pension schemes.—Applications will be treated in strict confidence. Write BOX "R13/4/55," c/o 95, BISHOPSGATE, E.C.2. G 543

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Publication dates have not yet been established. Further details concerning these titles will be issued as and when available.

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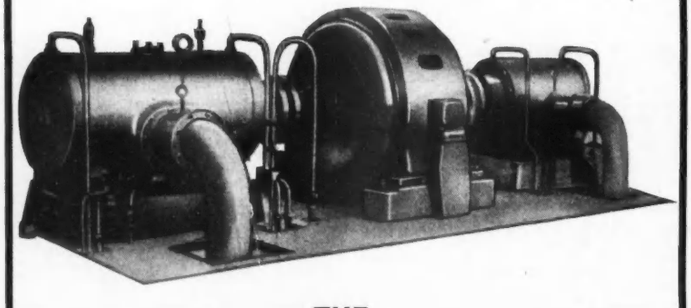

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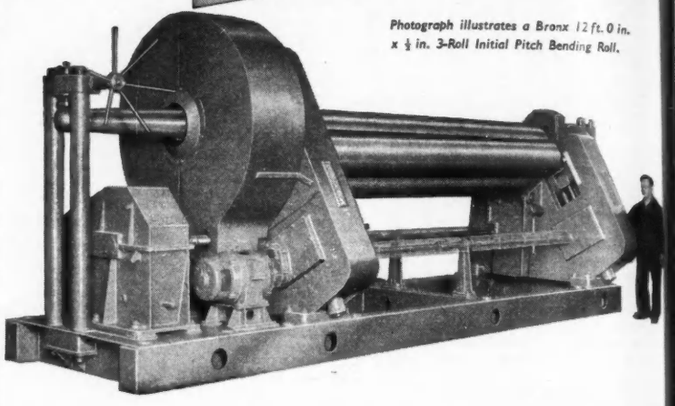

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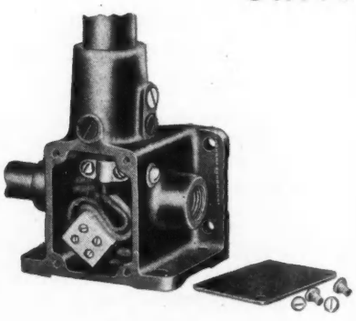

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Transistors are also being successfully employed in the development of equipments as diverse as computing machines (electronic brains) and portable gramophones, telephone equipment and nuclear radiation counters. And this is only a beginning. Research continues, and it is still impossible to foresee the ultimate extent of transistor applications, although potentially they appear to be unlimited. Whatever the future may bring, the Mullard organisation will play its traditional part in supplying British equipment manufacturers with electronic devices of the most advanced design and the highest quality.

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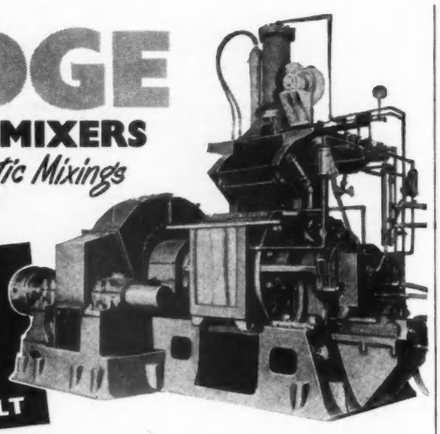

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Size of Machine	Net Volume of Chamber		Approx. Batch Size in lb. Spec. Gravity x Factor	Motor H.p.	Motor Speed	Length	Floor Length	Space Width	Width
	cu. in.	c.c.			r.p.m.	ft. in.	mm.	ft. in.	mm.
B	103	1,690	Sp. G. x 2·5	7½	710	5 0	1,524	4 0	1,218
00	263	4,310	Sp. G. x 4	10	485	8 0	2,436	4 0	1,218
1	1,140	18,700	Sp. G. x 24	40	485	13 6	4,114	7 6	2,286
3A	4,562	74,750	Sp. G. x 100	100	485	15 0	4,572	8 0	2,436
9	11,443	187,500	Sp. G. x 225	200	485	33 0	10,100	9 6	2,895
11	15,469	253,500	Sp. G. x 300	250	485	27 0	8,228	11 0	3,352

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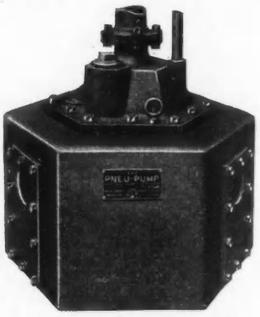

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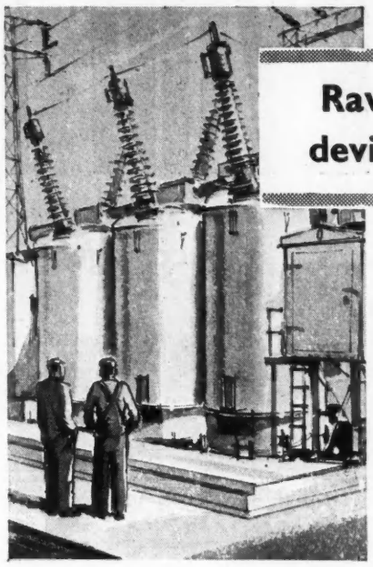

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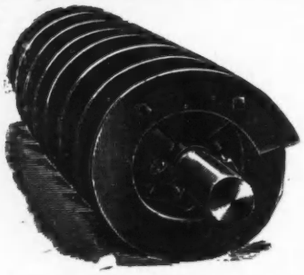

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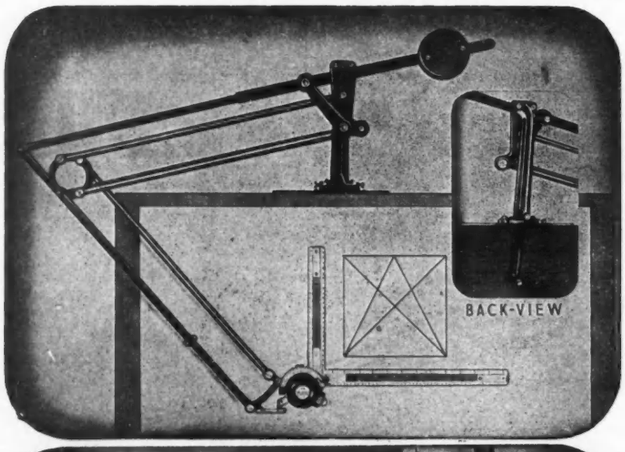

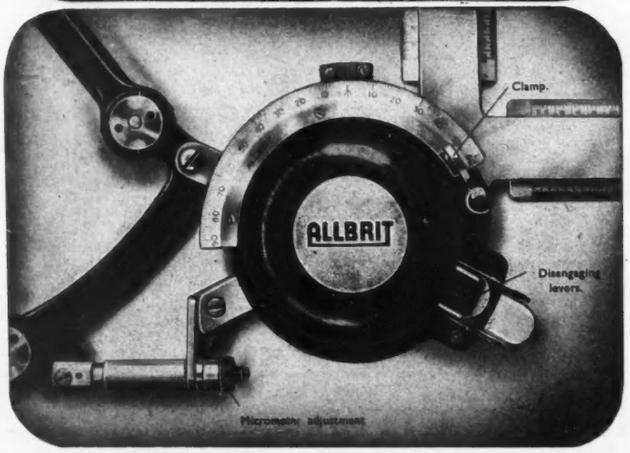

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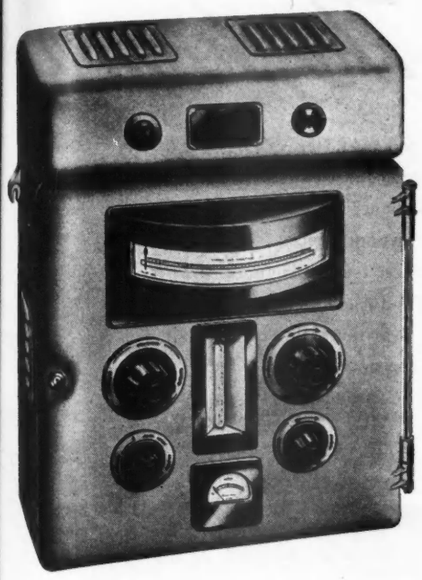

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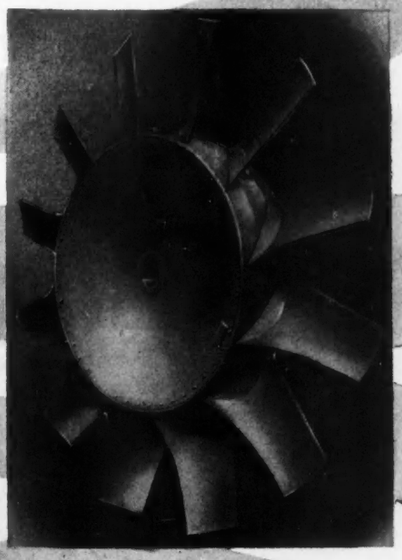

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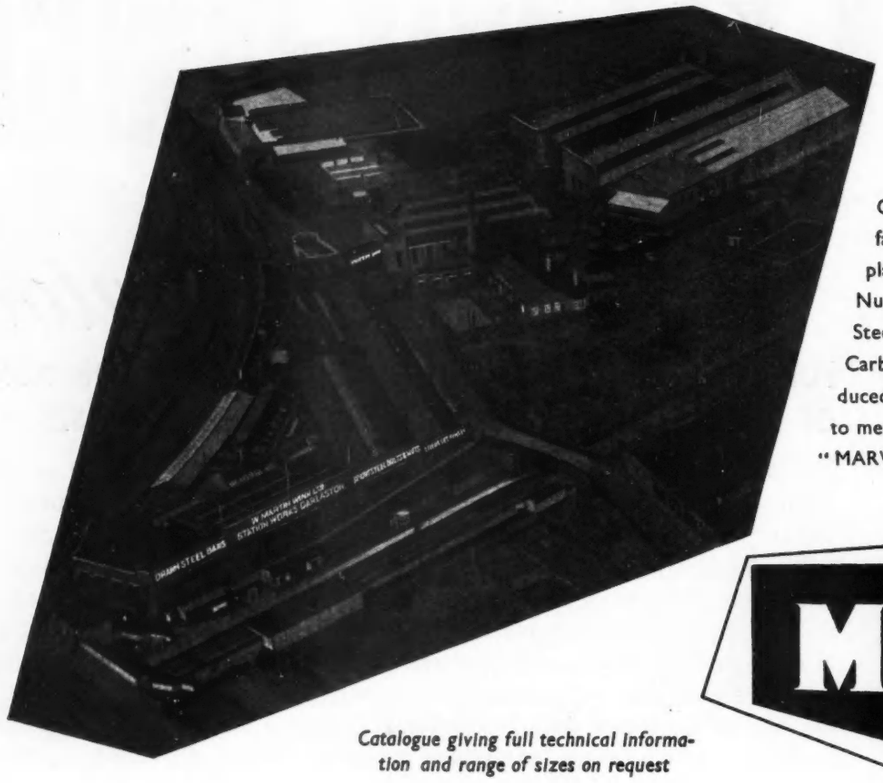

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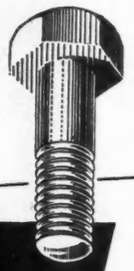

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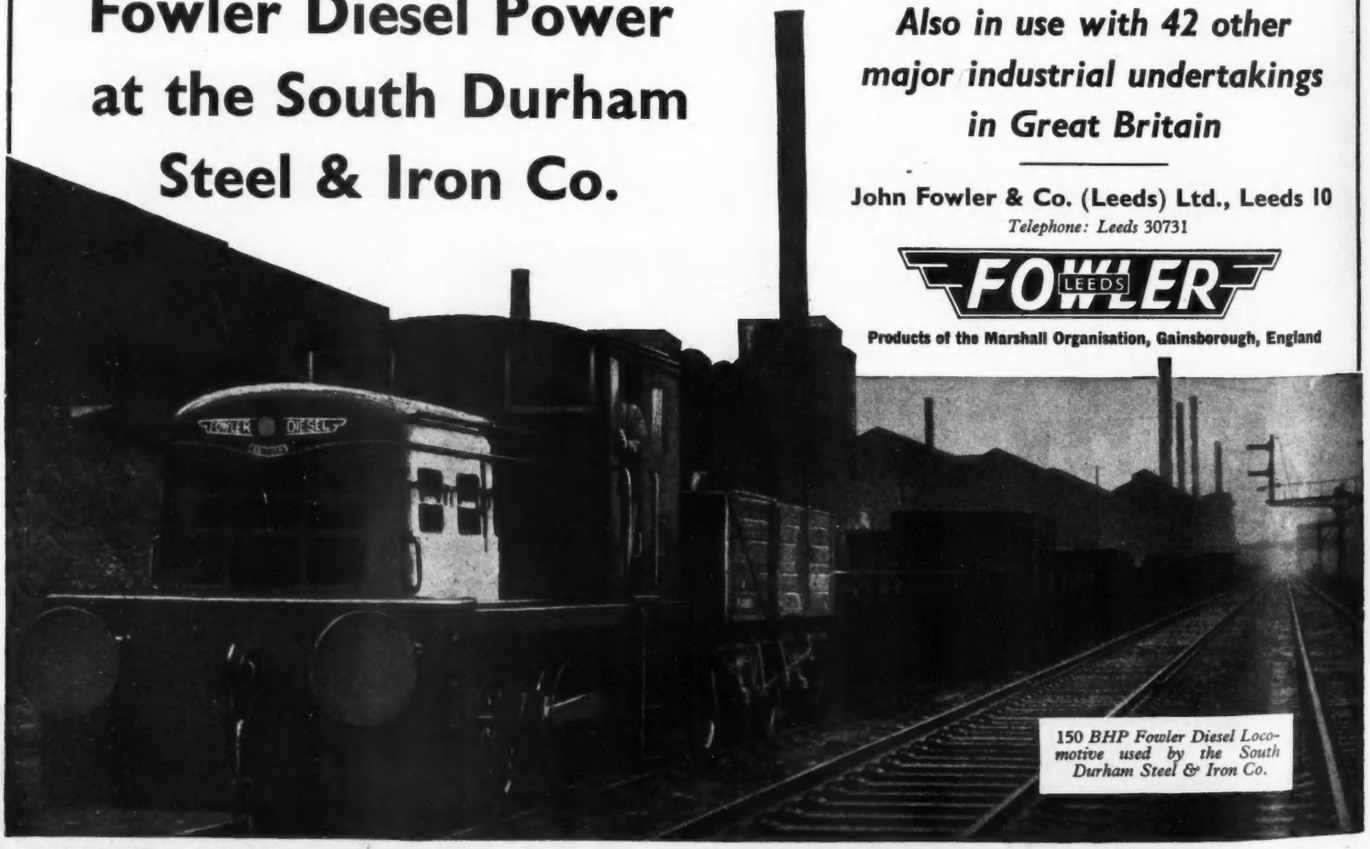

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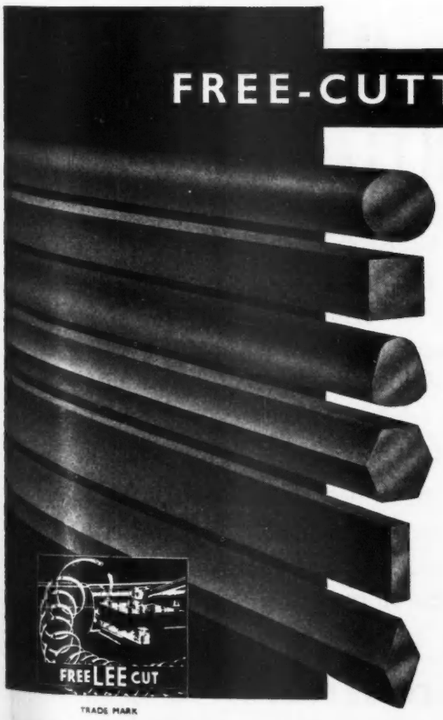

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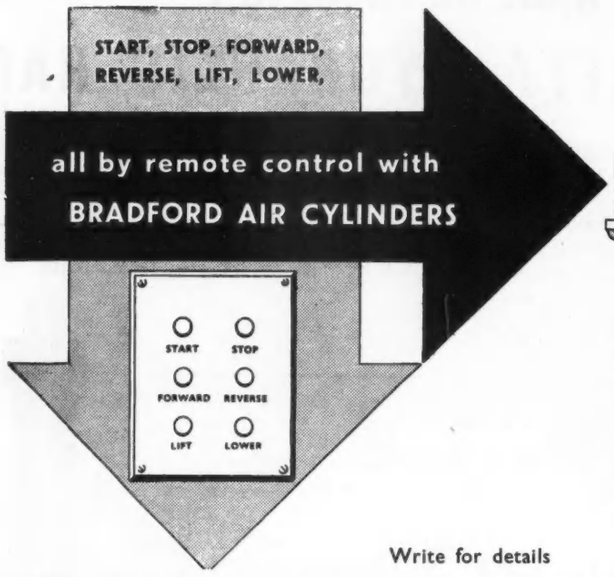

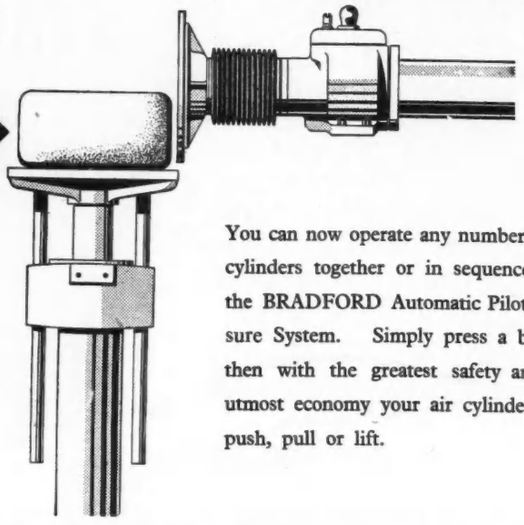

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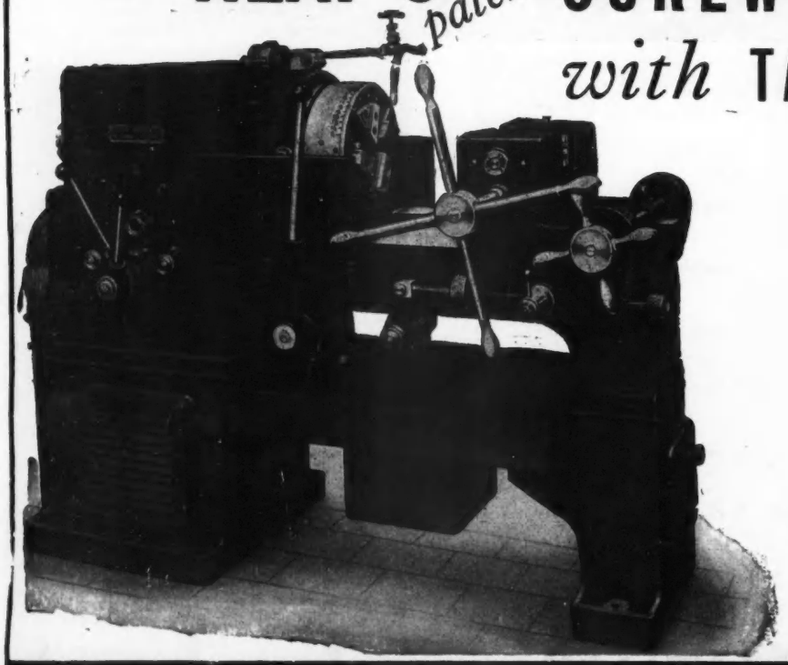

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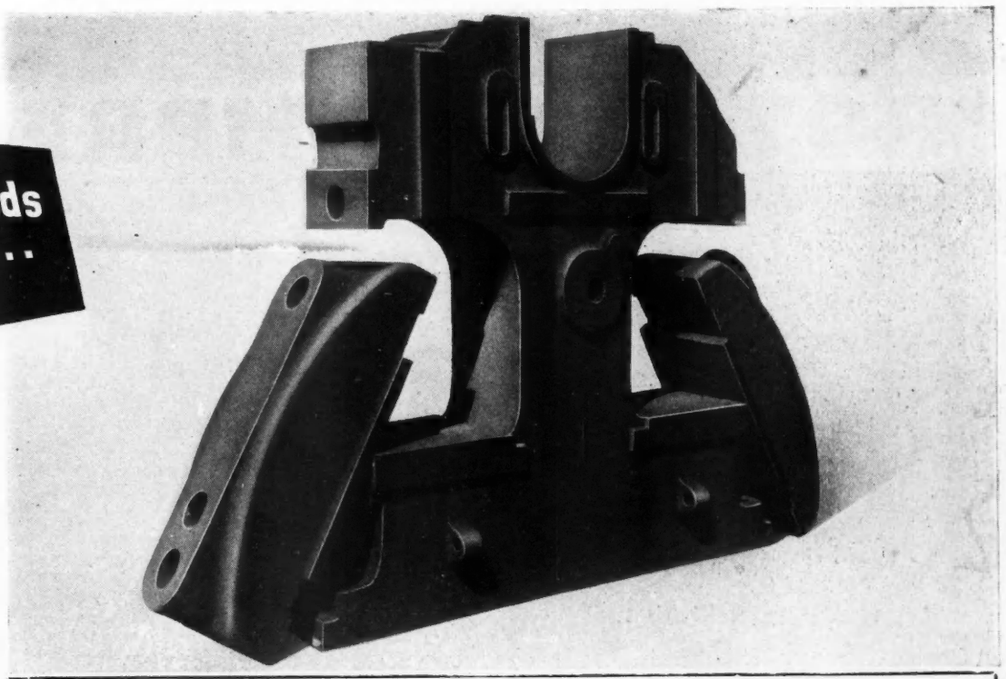

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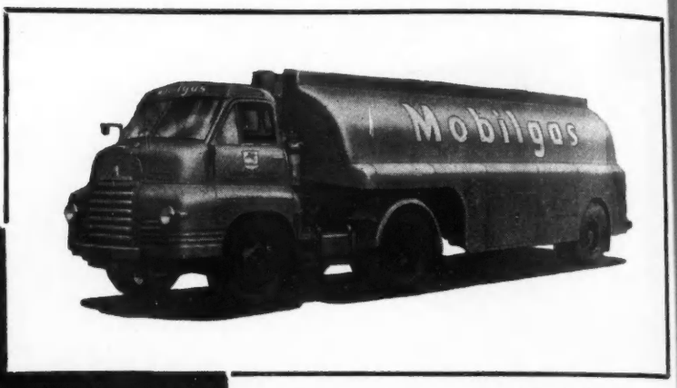

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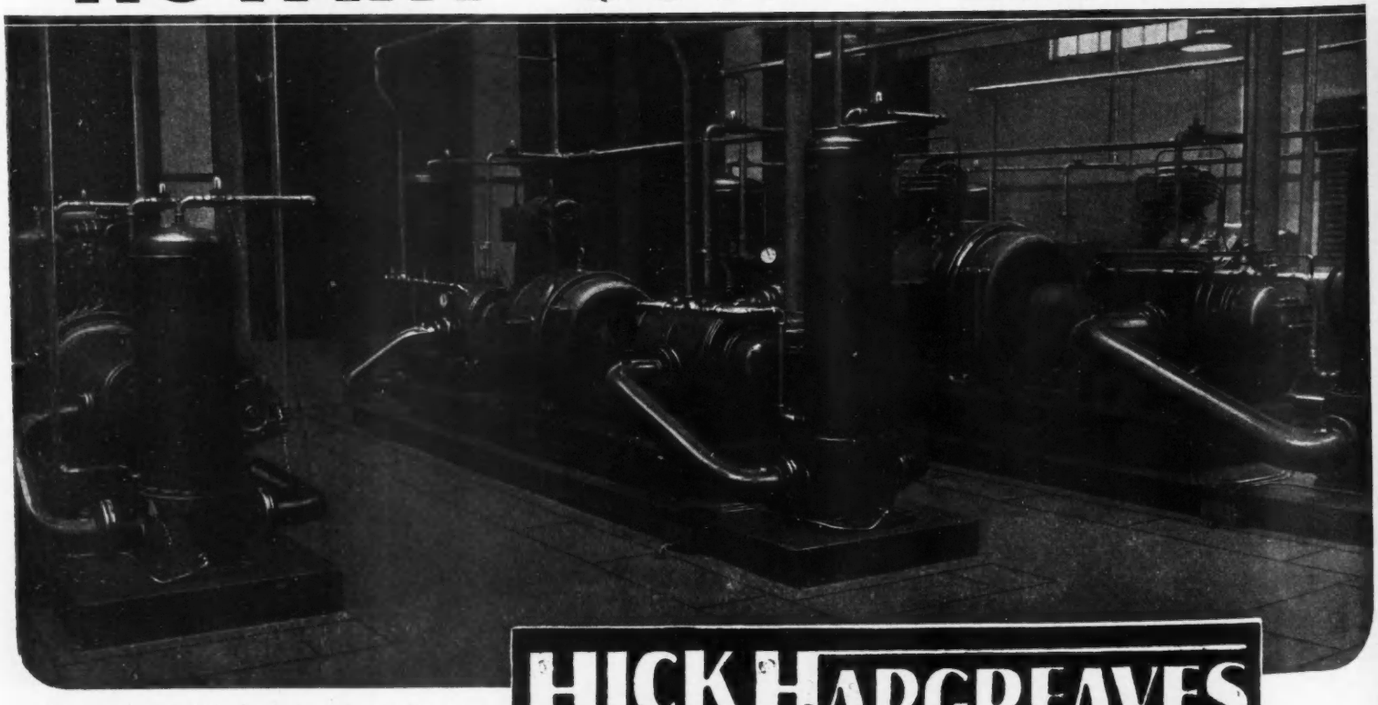

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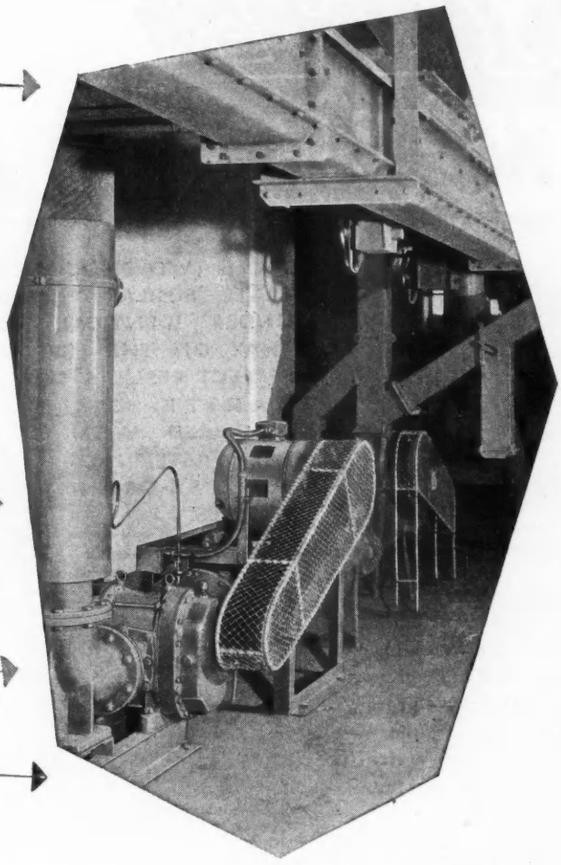

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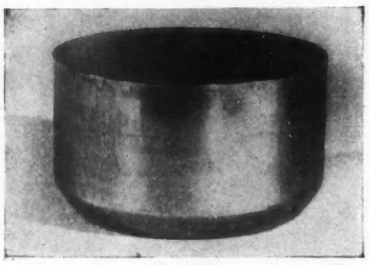
THE NEW METAL FOR PRESS TOOLS AND DRAWING DIES



THESE TWO PHOTOGRAPHS ILLUSTRATE SIMILAR PRESSINGS MADE UNDER IDENTICAL CONDITIONS. THAT ON THE LEFT SHOWS THE PERFECT RESULTS OBTAINED WITH NARITE DIES, COMPARED WITH THE WASTER PRODUCED BY ORDINARY DIES.

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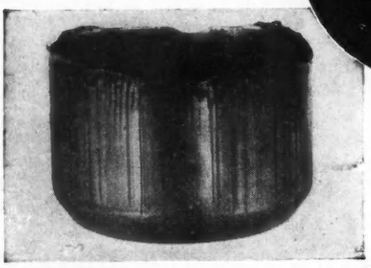

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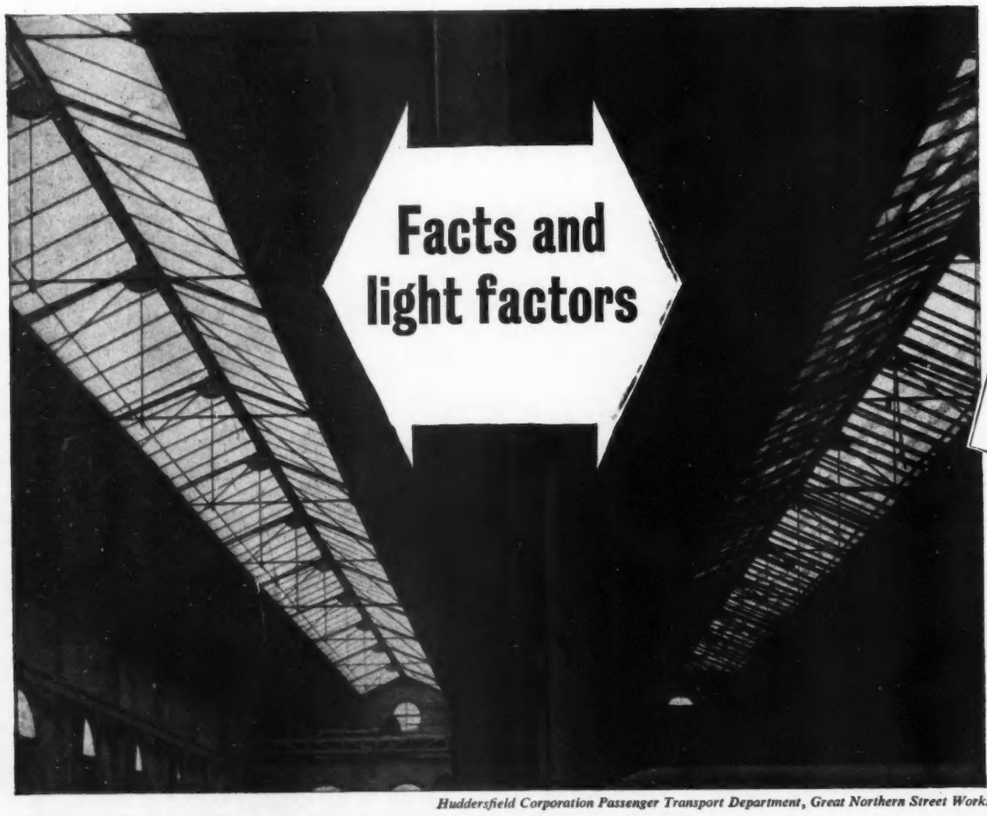

Light factor readings taken in the above premises will be of interest.
New glazing 60 foot-candles
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The installation of modern patent glazing does give the greatest possible daylighting efficiency. Whether your premises are large or small, new or old, industrial economics demand the admittance of maximum daylight to ensure highest productivity and sound working conditions. The above photograph shows an unfinished re-glazing contract and illustrates the very marked natural lighting improvement after part installation of new patent glazing by Heywoods. Many years experience combined with ample resources enable Heywoods to provide first class workmanship and efficient service. Your requirements would receive our interest and prompt attention.

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BRUSH SQUARE PATH ALTERNATORS are fully guaranteed and conform to the highest standards of engineering.

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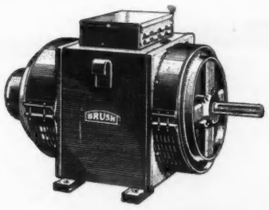

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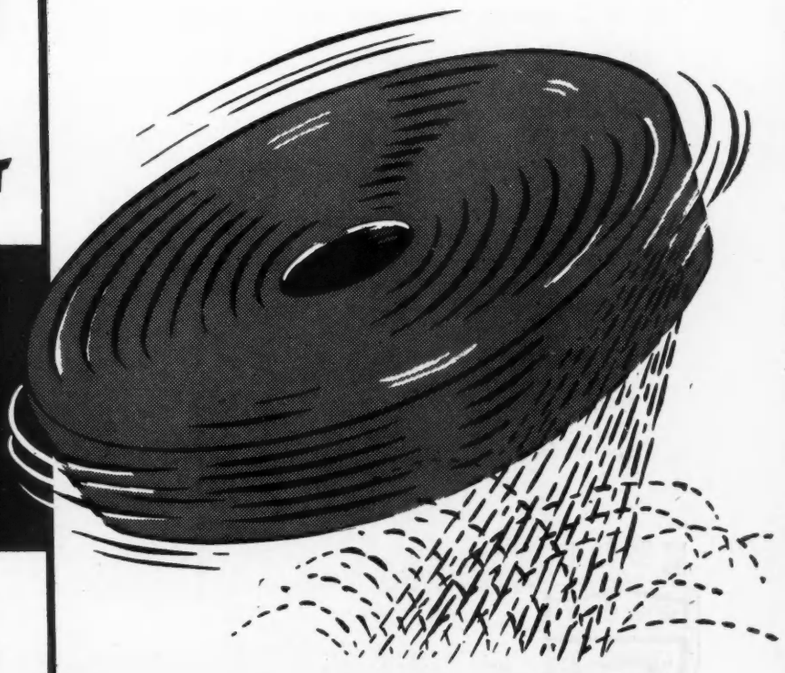

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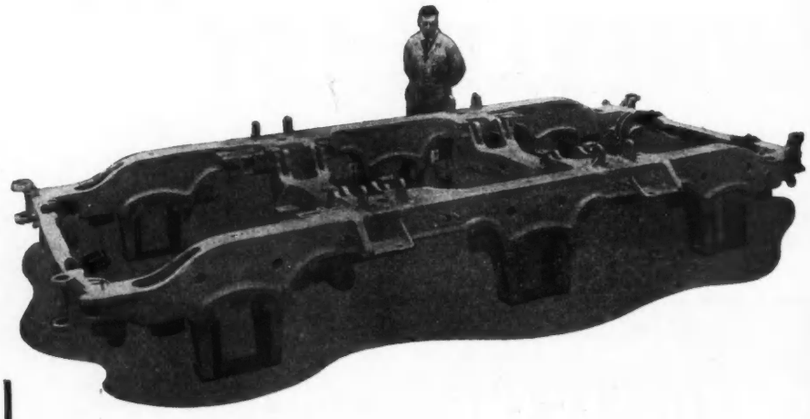

ESC Railway Products include "Commonwealth" cast steel bogies of the latest design, the one-piece construction of which provides maximum strength for minimum weight. They have a long maintenance-free life and are most economical in operation as rolling stock fitted with these castings spends less time out of service.

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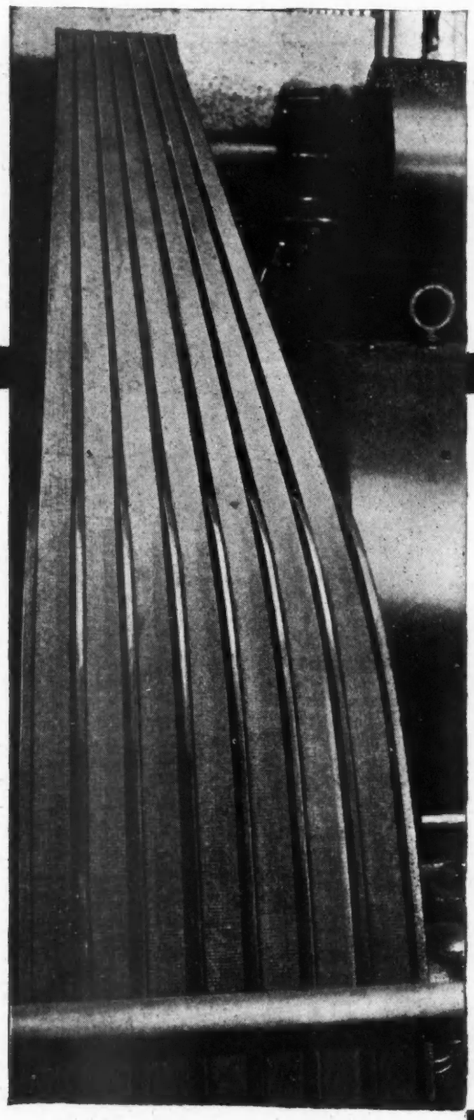

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Made to B.S.S. 1440/1948

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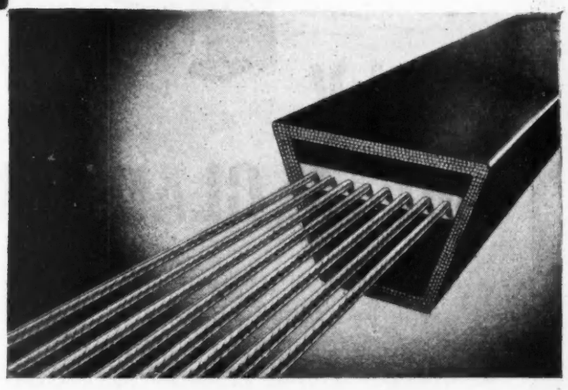

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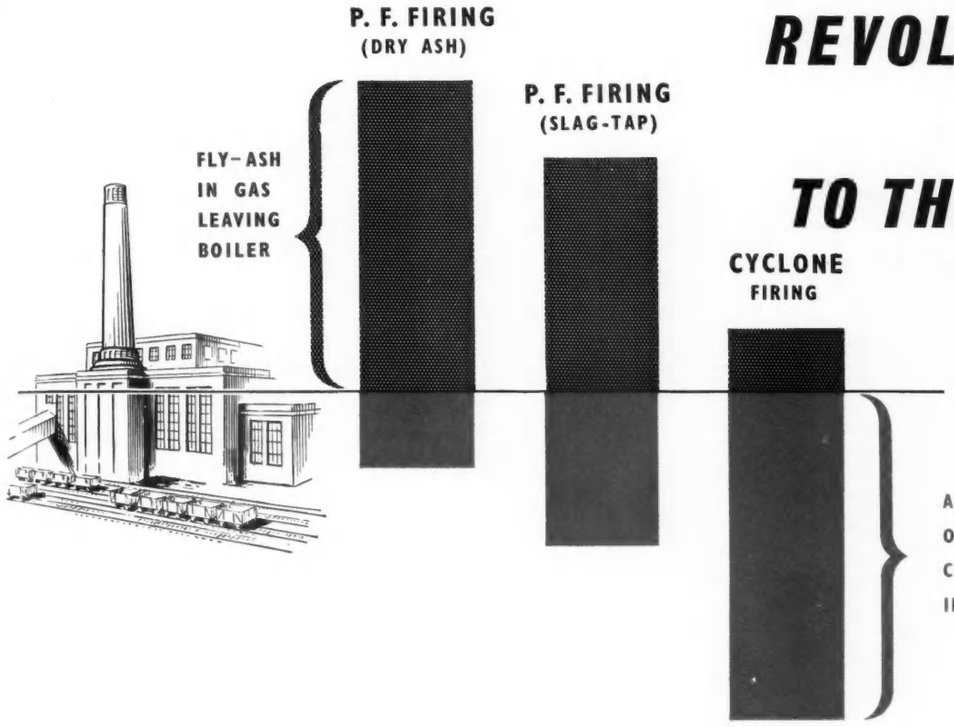
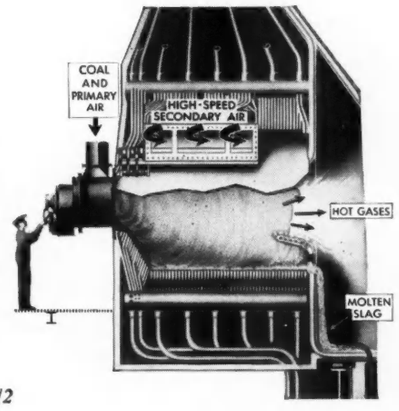


REVOLUTIONARY SOLUTION TO THE FLY-ASH PROBLEM

BABCOCK *CYCLONE* FIRING

Outstanding advantage of the *Cyclone* furnace is the enormous reduction in quantity of fly-ash passing through the boiler. The major problems of ash collection and disposal and of stack emission are greatly simplified; while boiler efficiency and availability are increased by the reduction of slagging and deposits on the boiler surfaces. The *Cyclone* converts the ash to molten slag, which is quenched and easily disposed of.

A Babcock development, the *Cyclone* furnace, after many years of research and full-scale service, is now established as one of the most effective methods of coal-firing power station and large industrial boilers, with these further important advantages:—



The coal is borne into the water-cooled refractory-lined furnace by a stream of high-velocity primary air and meets a tangential stream of high-velocity secondary air, forming a vortex of flame in which the fuel is completely burned, the hot gases passing into the boiler. The temperature in the *Cyclone* is high enough to liquify the ash which clings to the walls, forming a continuous coating of molten slag, which flows out of the furnace and is tapped into a water-filled tank.

ASK FOR PUBLICATION 1508/2

Highest boiler efficiency due to efficient combustion, cleaner boiler surfaces, and lower power consumption for coal preparation—since the coal need only be crushed or coarsely pulverized.

Burns even poor grade, high-ash coals, at high combustion rates.

Due to high ash recovery and simpler ash disposal and coal preparation, removes various causes of heavy maintenance and shut-down; so further improving boiler availability.

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Ideally suited to simple, automatic combustion control. Safe in operation. Easily started up. Ignition stable under all load conditions.

Flexible in operation to meet wide load variations. Can be arranged for alternative firing with oil or gas.

Babcock & Wilcox Ltd. have under construction and on order, a number of *Cyclone*-fired boilers for both power station and large industrial installations.

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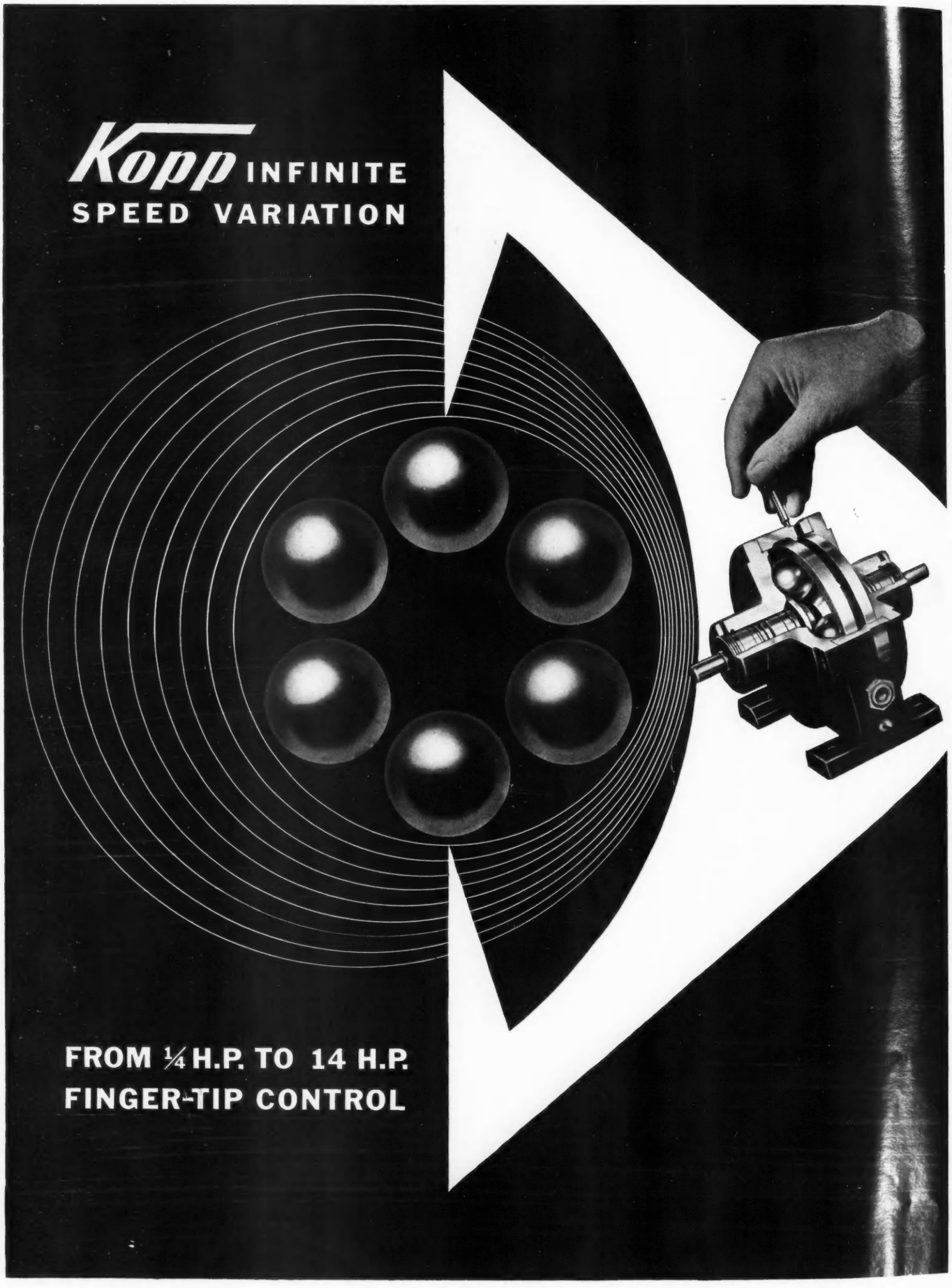

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Fusarc Unionmelt

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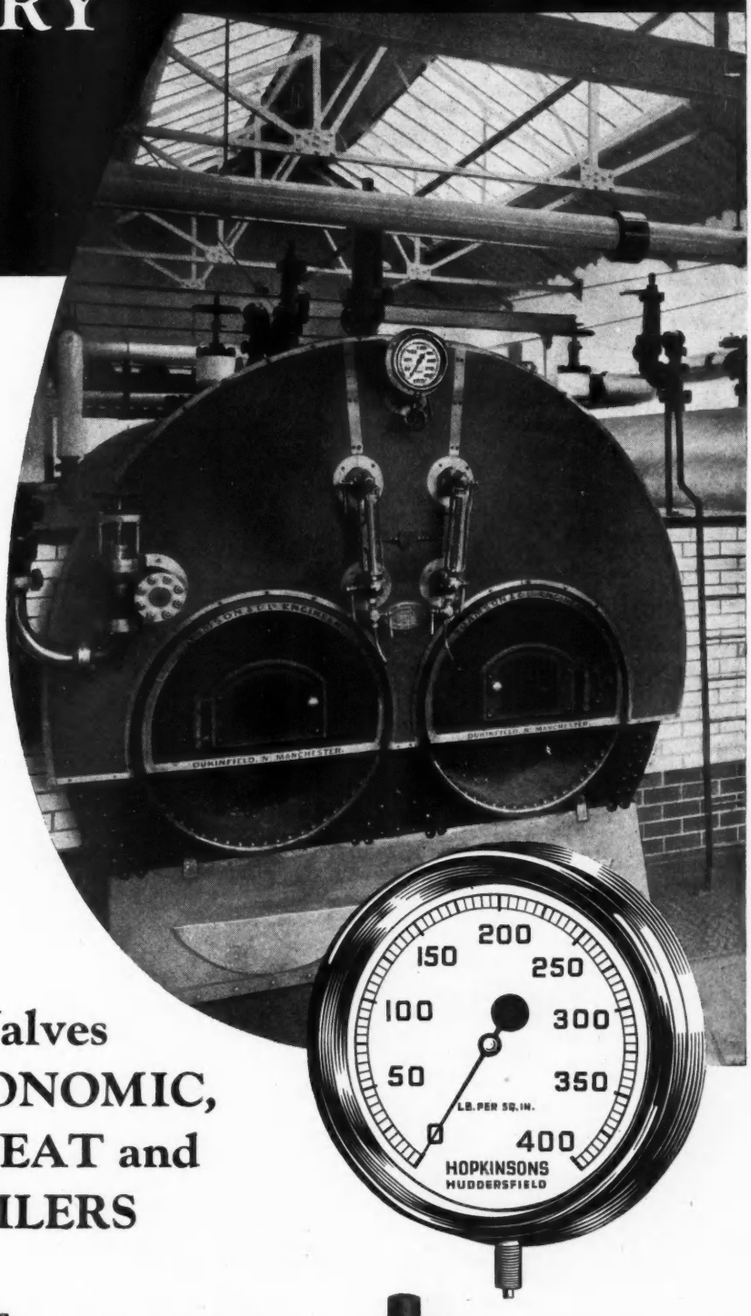
ALL Hopkinsons' experience goes into EVERY Hopkinsons' product



Hopkinsons' success in the field of high pressure power station boiler practice sometimes may tend to obscure the fact that they make equally good boiler mountings and valves for industrial boilers. You do, in fact, in equipment for lower pressures, get the benefit of all Hopkinsons' experience in the most exacting fields. All Hopkinsons' experience goes into every Hopkinsons' boiler mounting or valve, because dependability is just as essential to the user of an industrial boiler as in a large power station.

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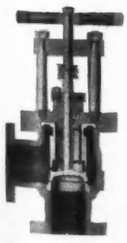
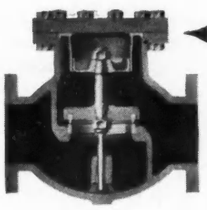
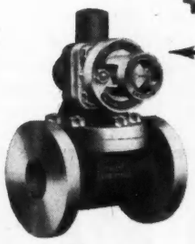


← Combined Stop and Non-return Feed Valve, designed for accurate seating and smooth action.



← Automatic Isolating Valve, for use where two or more boilers are connected to a common steam main.



← Patent Parallel-slide Blow-off Valve. Full-way uninterrupted passage through the valve.

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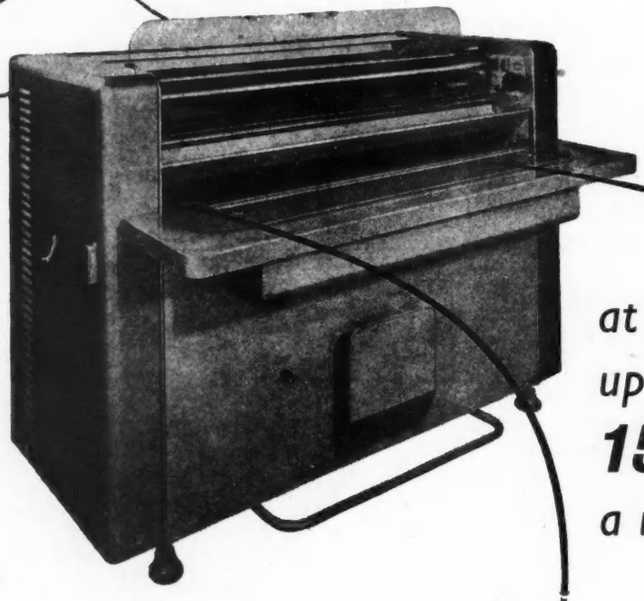

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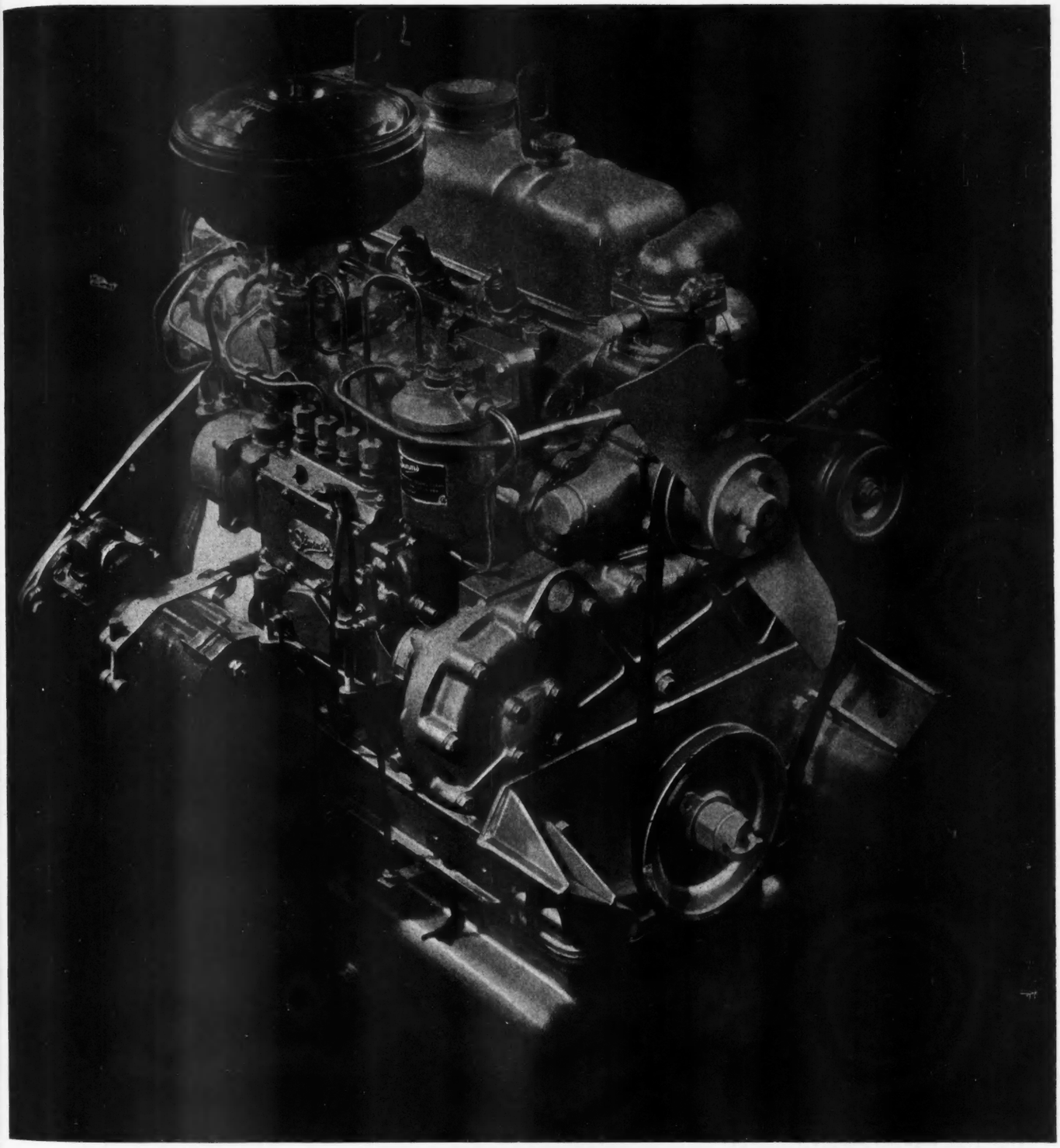

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Newage-BMC 3.4 litre diesel engine. Each basic power unit can be fitted with a variety of components to suit particular applications and can be adapted for stationary as well as mobile equipment.

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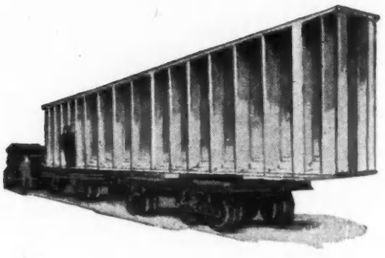

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in Graving Dock Pumping Stations

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The valves supplied have included some of the largest electrically operated sluice valves ever made, in sizes up to 108 in. dia.

108 in. dia. Sluice Valve for Graving Dock Pumping Station in N.S.W., Australia.

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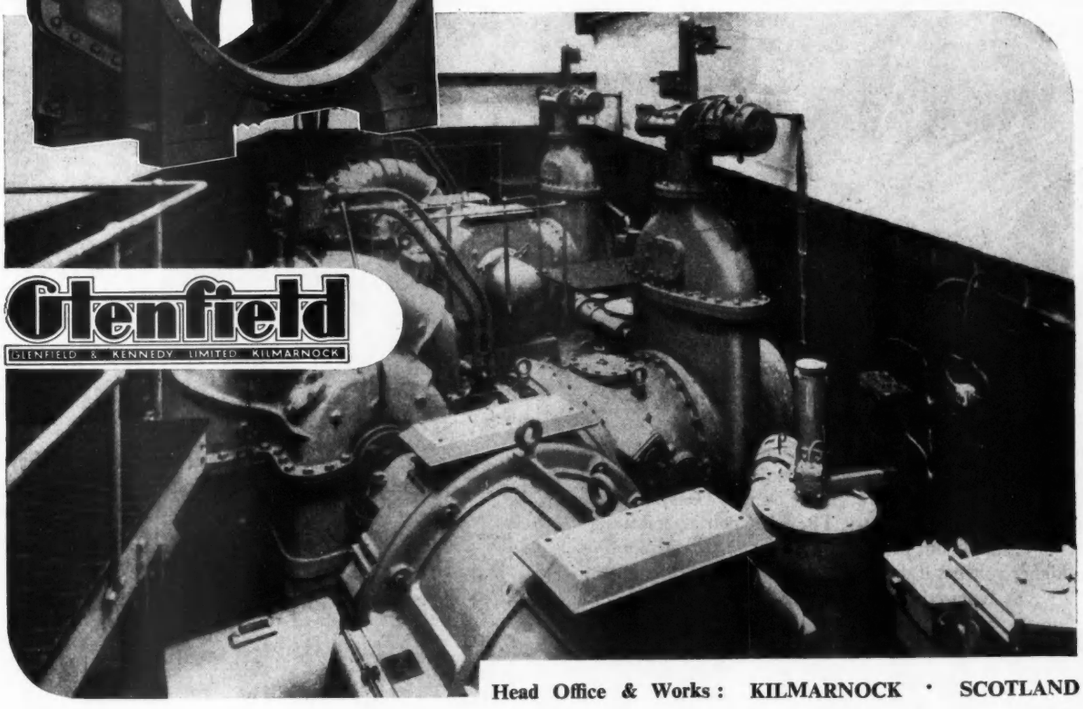

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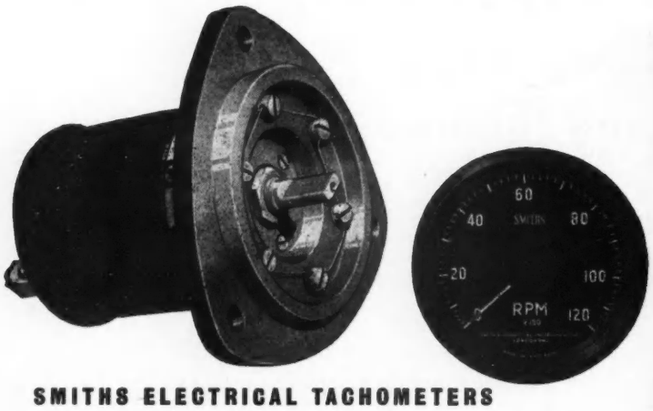
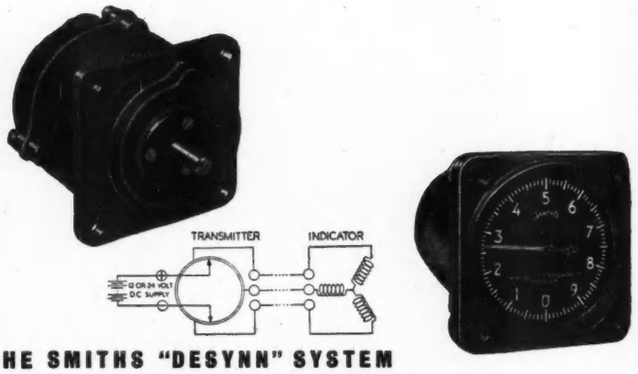
of rotational speeds; cutting speeds; conveyor speeds.



SMITHS ELECTRICAL TACHOMETERS

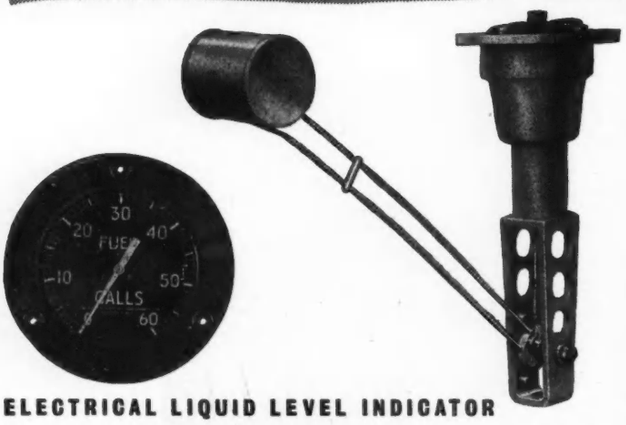
are ideally suited for applications in the industrial field, rail traction and for marine purposes, particularly where dual indication is required. The robustly constructed equipment, consisting of an A/C generator connected to the indicator by an electrical cable, facilitates panel installation and maintenance.

Pressure; force; displacement; temperature; fluid level etc.



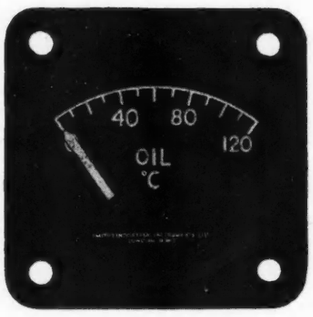
THE SMITHS "DESYNN" SYSTEM

has many applications in the industrial field for transmitting functional information such as Pressure, Force, Displacement, etc. It operates from 12v. or 24v. D/C supply and consists basically of a transmitter and, if required, two or more indicators.
The illustrations show a typical "Desynn" Position Indicator, used in conjunction with a Concentric Spindle Transmitter.



ELECTRICAL LIQUID LEVEL INDICATOR

This instrument provides accurate remote indication of liquid contents. The transmitter, or tank unit, is available in three basic designs and transmits through the Smiths "Desynn" system to one or more indicators. The equipment operates from 12v. or 24v. D/C supply but provision can be made to operate from higher voltages if desired. A transformer rectifier is required when operating from A/C supply.



ELECTRICAL RESISTANCE THERMOMETERS

These instruments measure, to a high degree of accuracy the temperatures of oil, water and electrical windings. The electrical transmitting thermometer bulb is connected to the instrument by cable and the circuit operates from 12v. or 24v. D/C supply. Provision can be made to operate from higher voltages if desired.

SMITHS

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Northern Sales Office: York House, 12 York Street, Manchester

The Industrial Instrument Division of S. Smith & Sons (England) Ltd.

AP 188-25a

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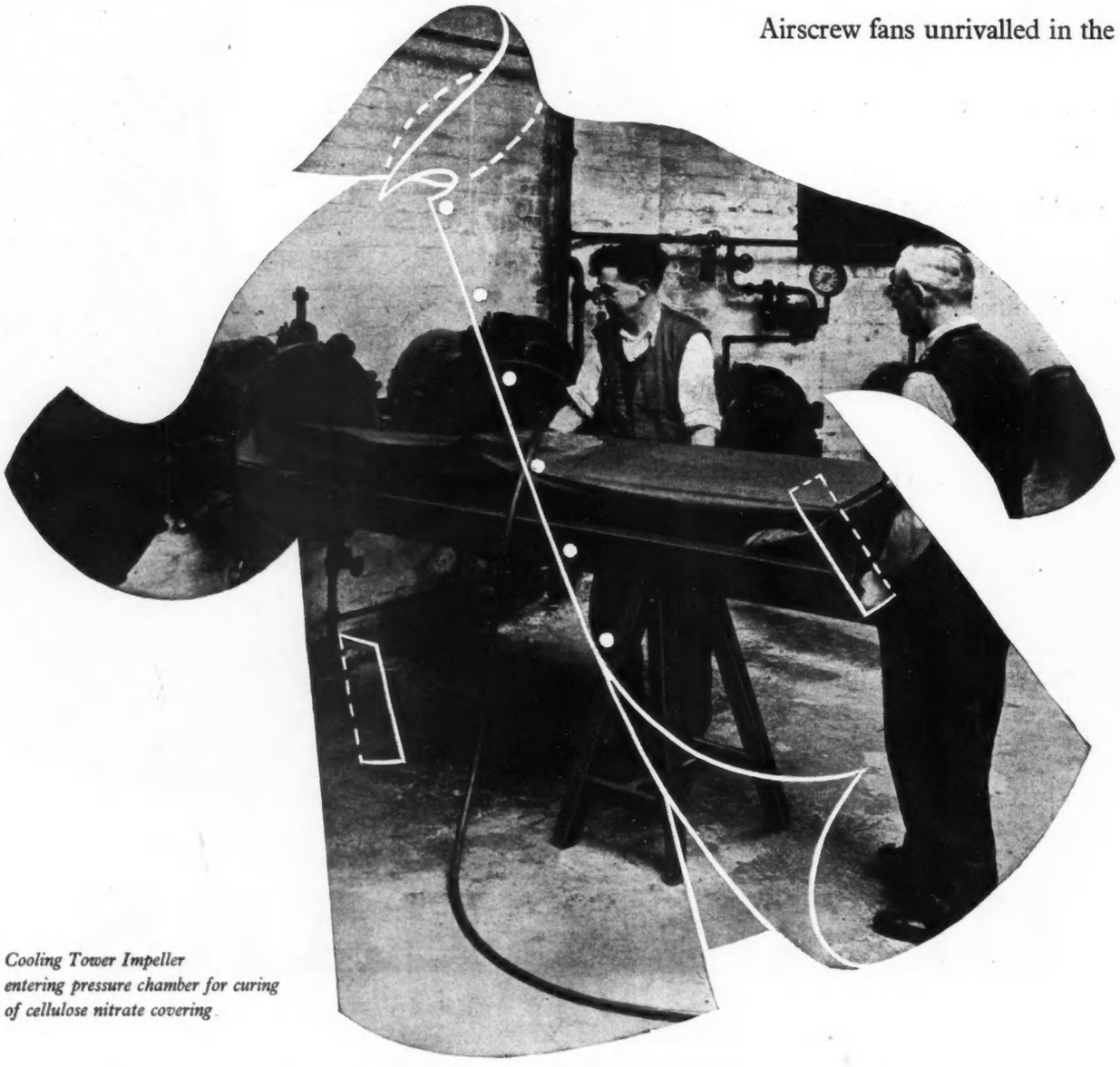

Cooling Tower Impeller entering pressure chamber for curing of cellulose nitrate covering

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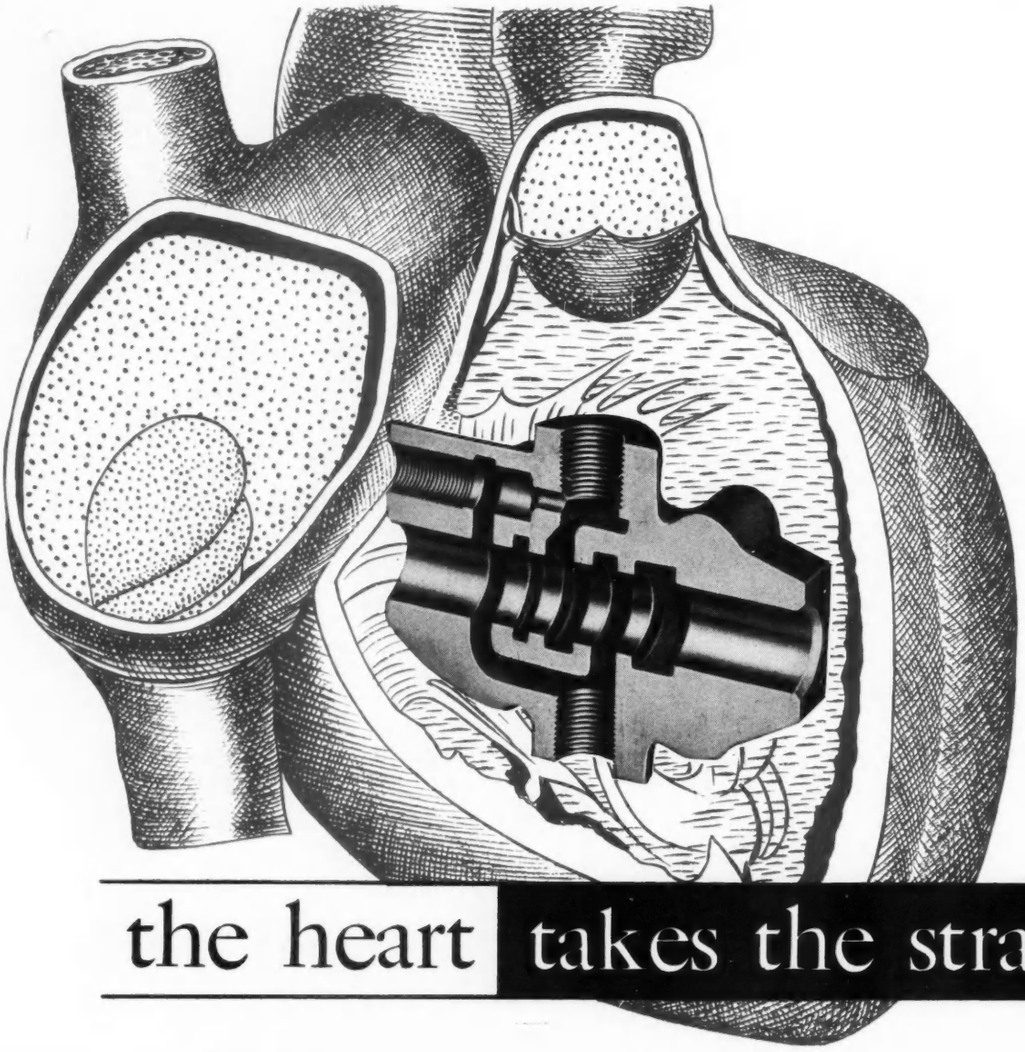

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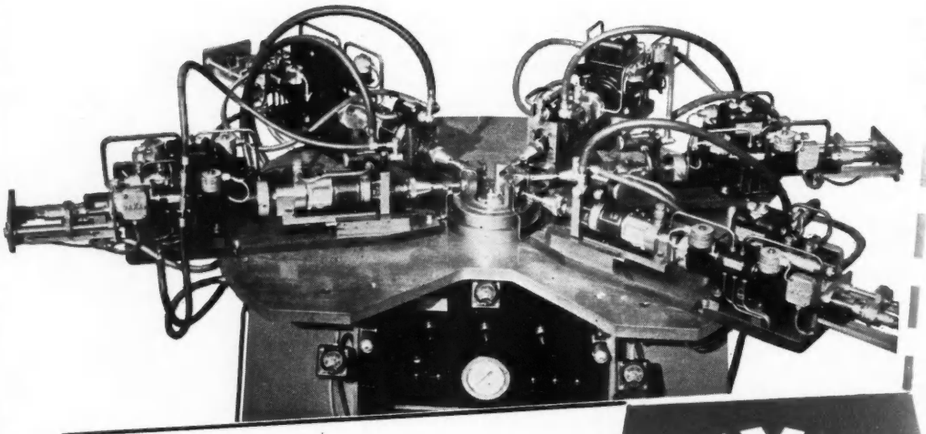

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MAXAM PNEUMATIC SYSTEM

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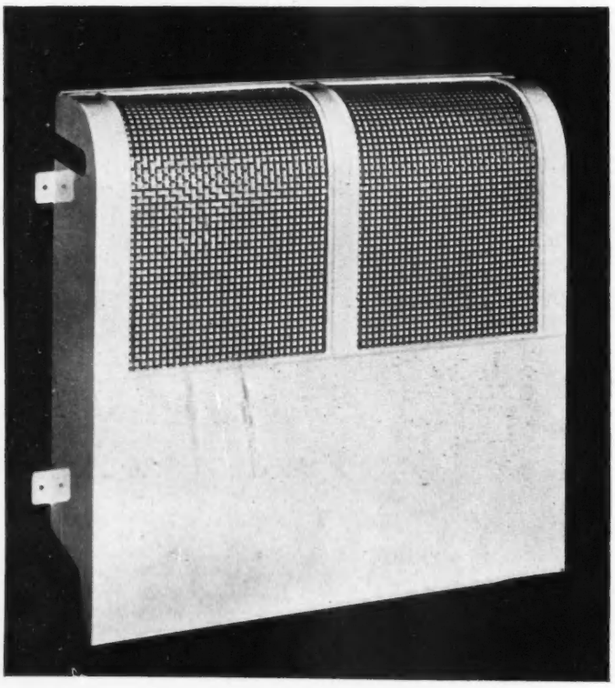

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KEY TO INDUSTRY *No. 7*

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The development of steel made possible the growth of civilisation itself. For steel is the key to the good things of life as well as to the necessities; as essential to the maker of the precision watch as to the bridge-builder. Hallamshire high-grade Alloy and Carbon steels serve a multitude of industries in many ways.

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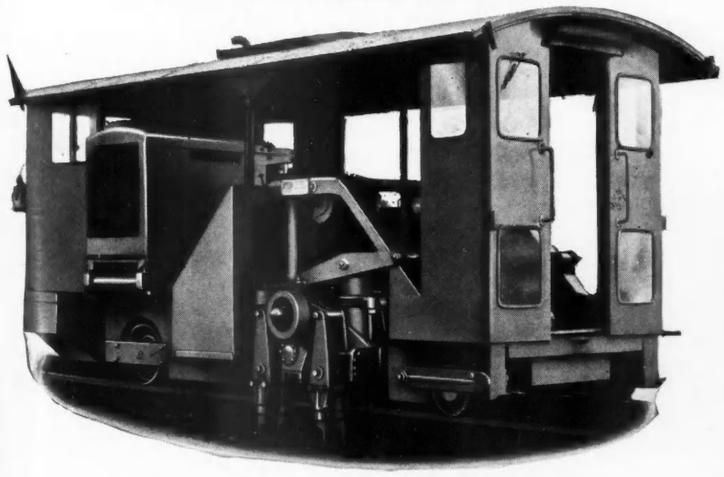

An associated item of Matisa railway track maintenance equipment is the rail ballast tamper, manfactured by Clayton Goodfellow & Co. Ltd., here seen in operation, powered by a Leyland PU.350.

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a matter of design

The design of Vokes filters, too, is contemporary . . . but it is based upon certain fundamental principles which are vital to complete engine protection. Consider, for instance, the felt fabric element of a Vokes lubricating oil filter. It filters in depth; it retains its efficiency at all temperatures and conditions and over many, many hours of arduous service. There is no medium like felt for oil filtration—just as there is no other filter like Vokes.

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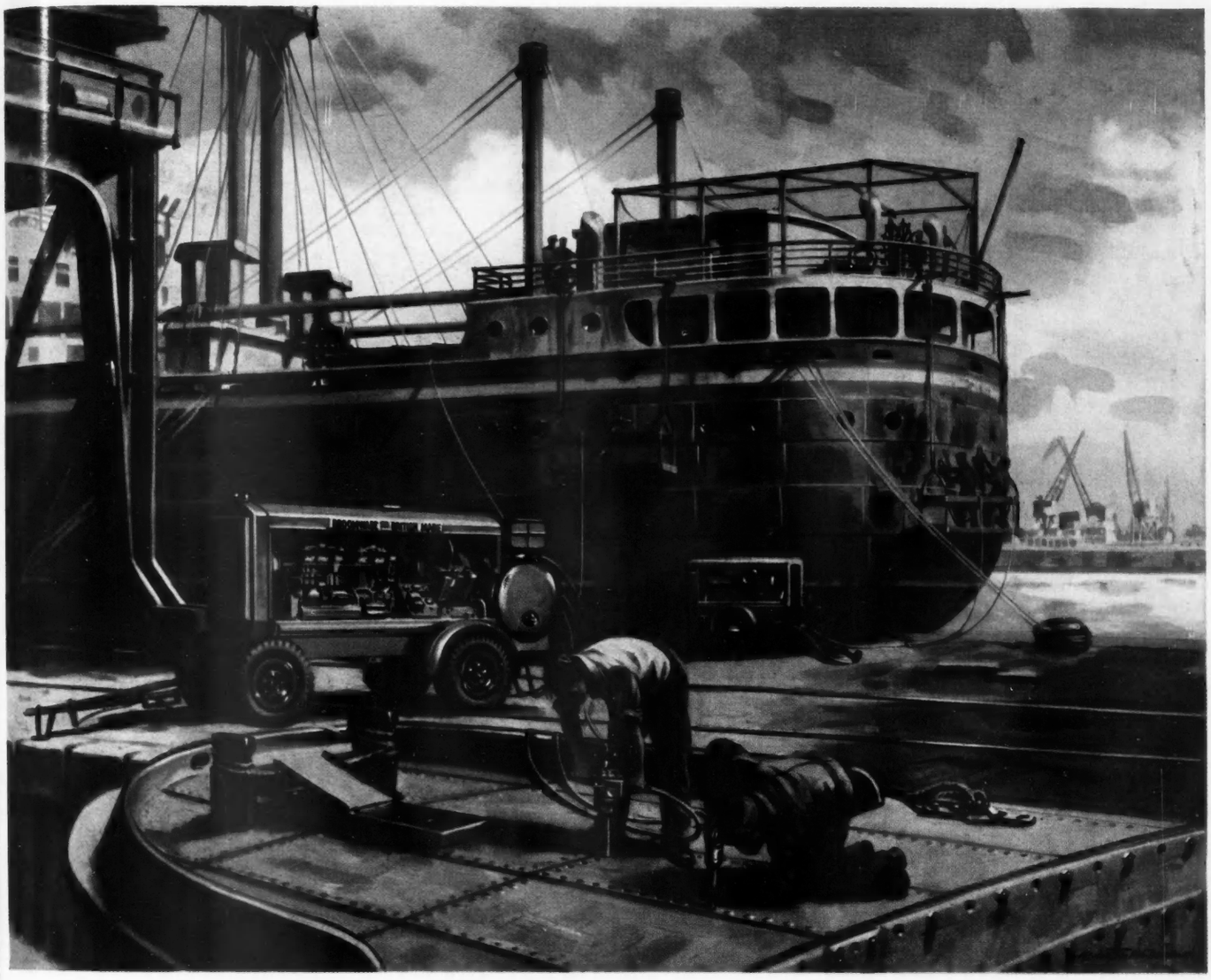

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... for effective sealing against most liquids and gases

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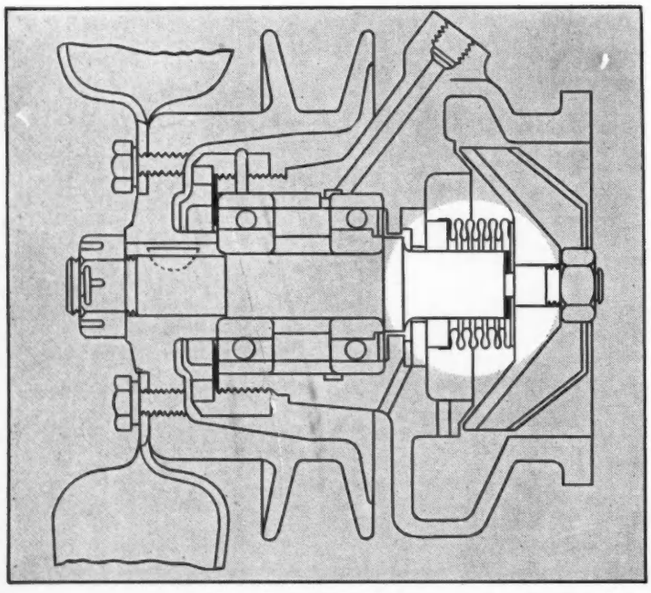

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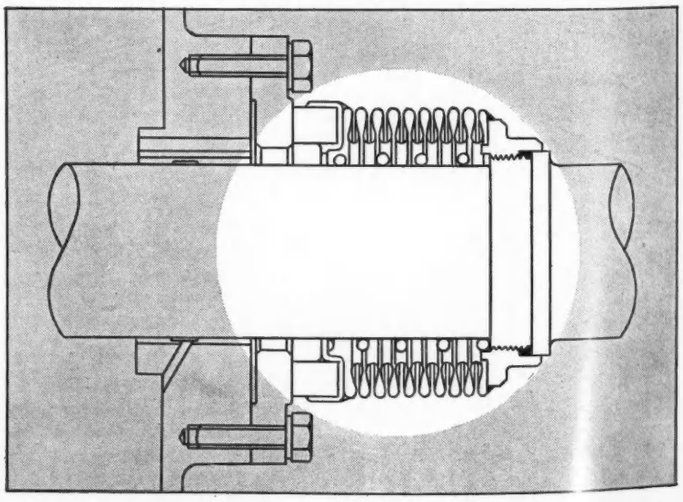

THE BRITISH THERMOSTAT CO. LTD., SUNBURY-ON-THAMES, MIDDLESEX. *Telephone: Sunbury-on-Thames 456*

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	MAXIMUM STRESS *t.s.i.*	YIELD POINT *t.s.i.*	ELONGATION *per cent.*
As-Cast (Pearlitic)	*37*	*27*	*1*
Annealed (Ferritic)	*27*	*20*	*10*

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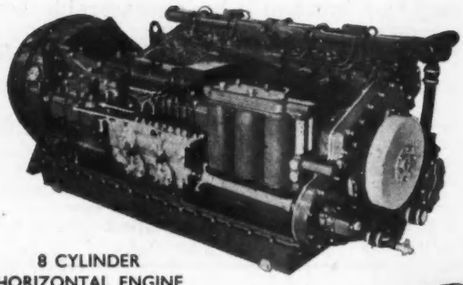
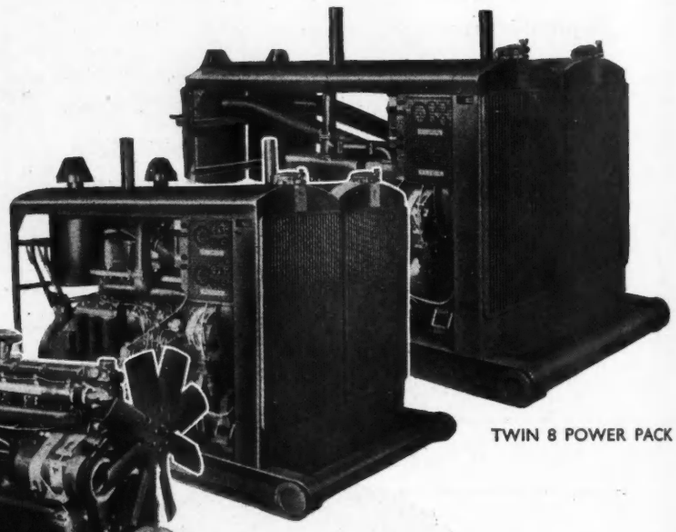
ROLLS-ROYCE

OIL ENGINES



8 CYLINDER HORIZONTAL ENGINE



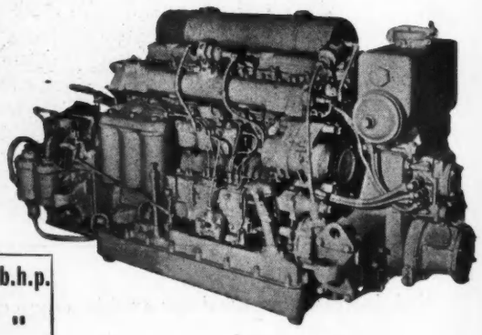
TWIN 8 POWER PACK

TWIN 6 POWER PACK

8 CYLINDER ENGINE

6 CYLINDER ENGINE

4 CYLINDER ENGINE



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Twin 6 Power Pack	160-370 ,,
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16. **Guy** "Arab" P.S.V. Chassis.
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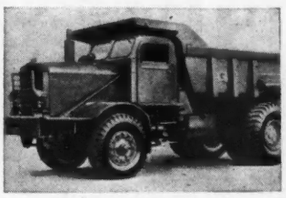
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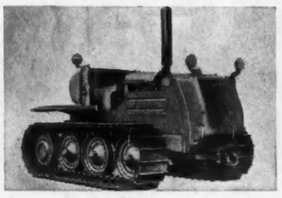
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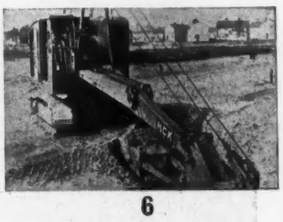
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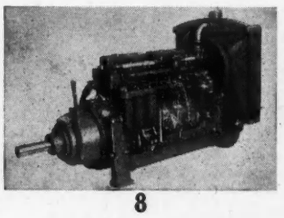
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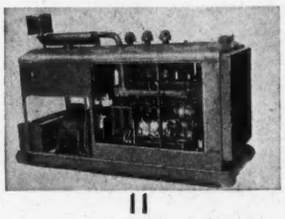
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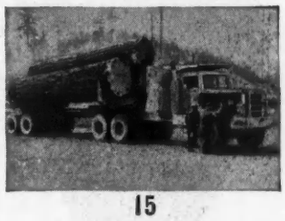
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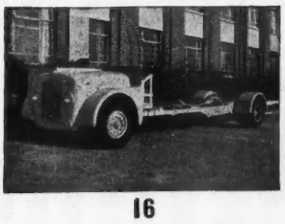
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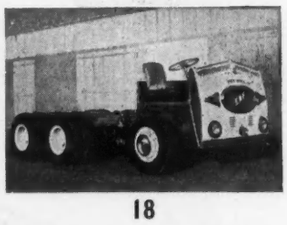
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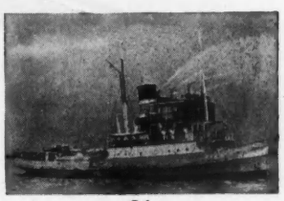
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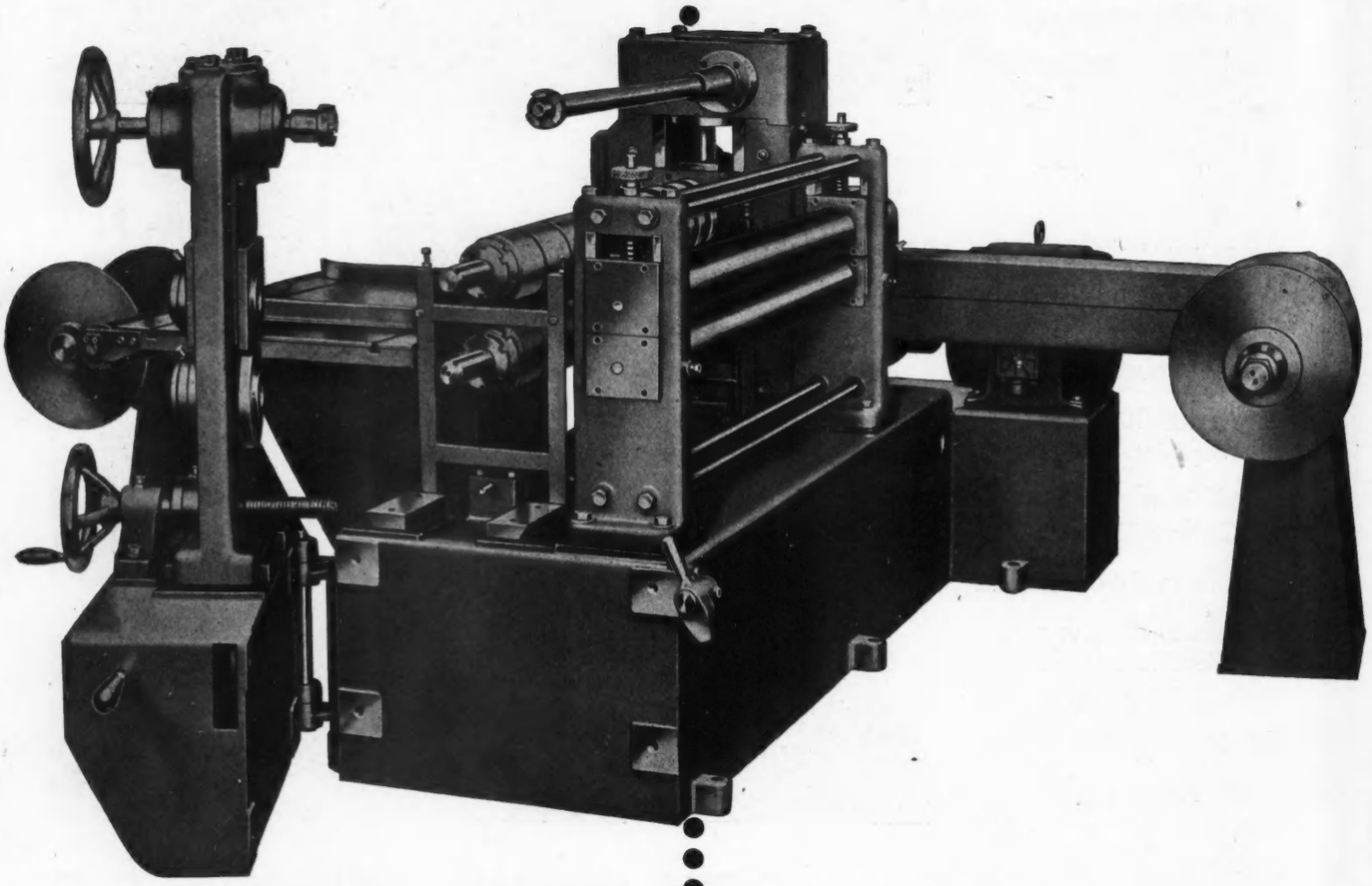
DIVISION, DERBY, ENGLAND

Gangslitters



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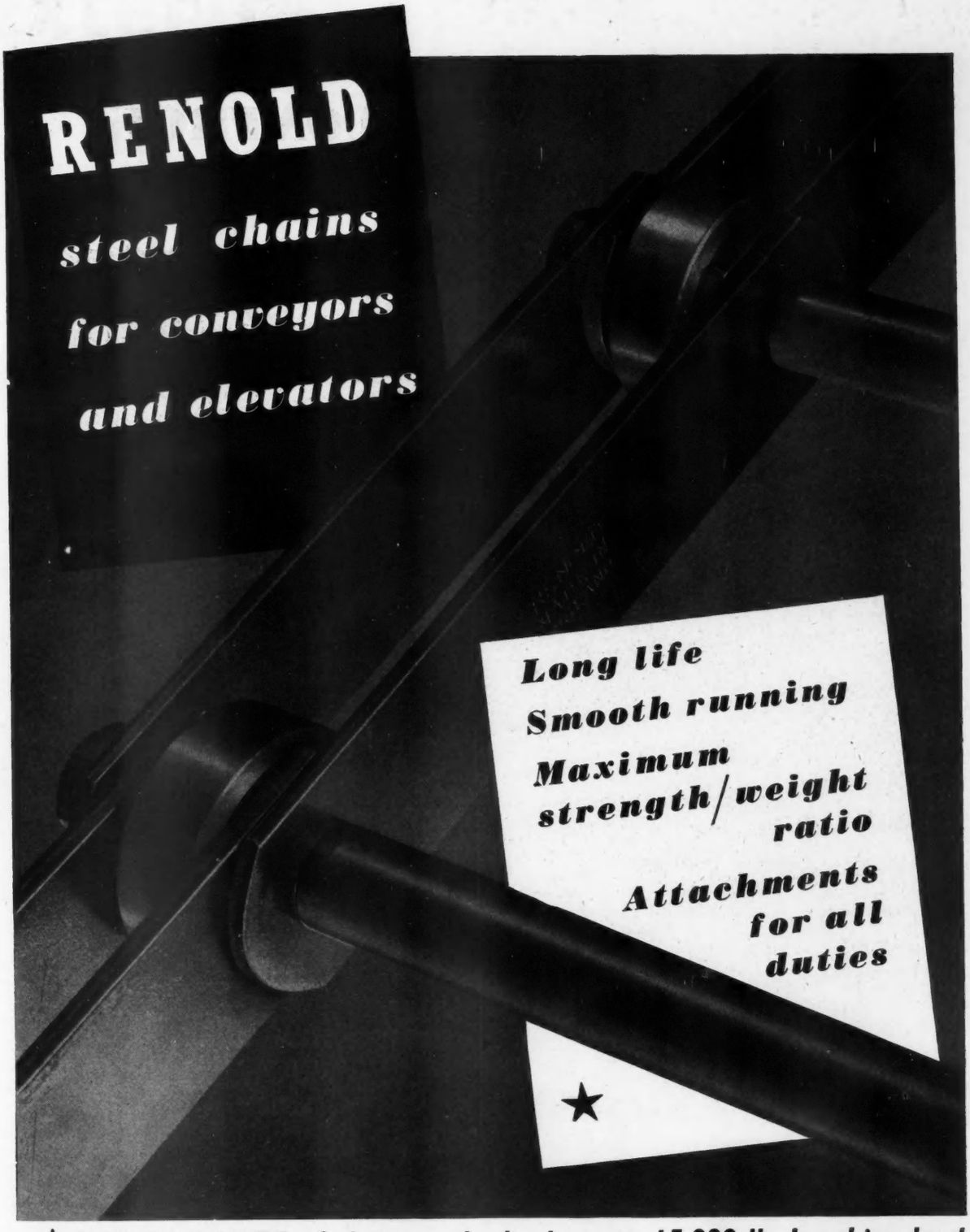

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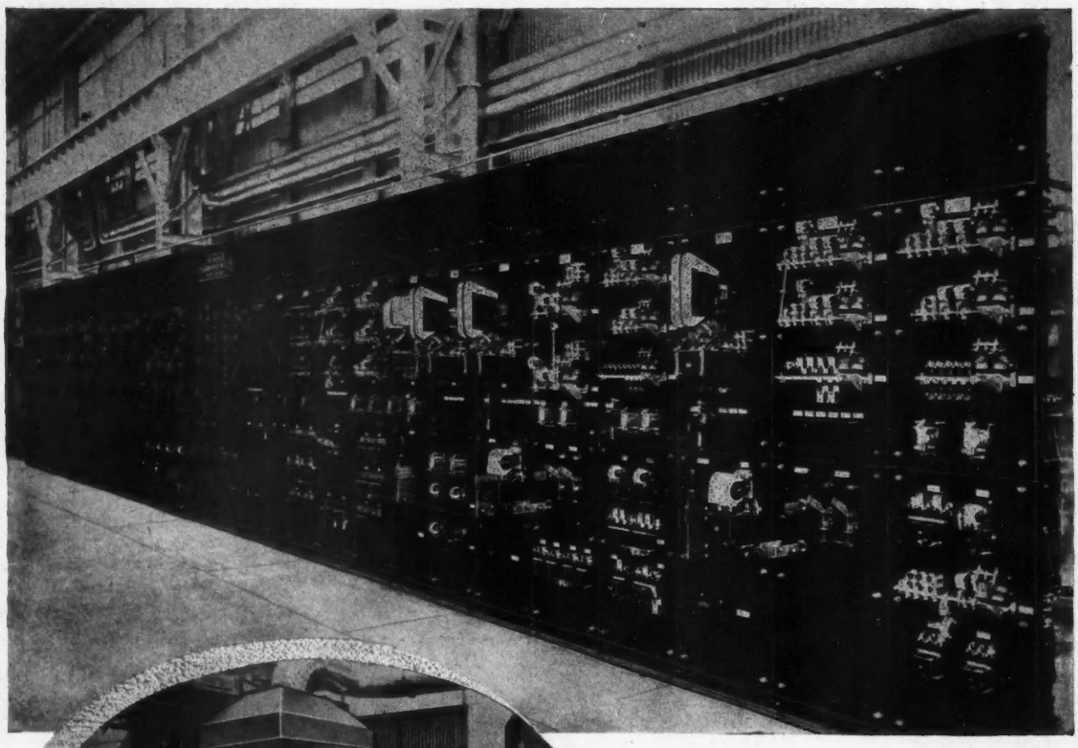
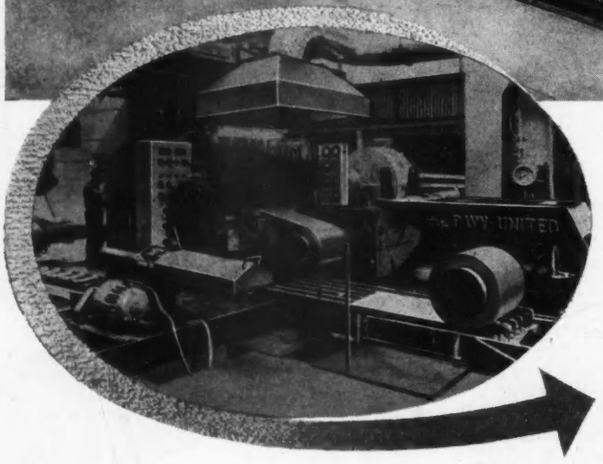
CONTACTOR CONTROL for Heavy Industry





The CONTACTOR EQUIPMENT illustrated above is controlling motors totalling 1,670 h.p. driving the Temper Mill and Slitter (Cold Strip Mill) at the Rogerstone Works of Messrs. Northern Aluminium Company Ltd. Inset is shown the Temper Mill.

For more than forty years BTH has held a position of leadership in the development of automatic "finger-tip" control of heavy electric plant through the medium of contactors. These contactors, designed by experts, are proved by protracted "life tests" before going into service.

Where only the best is good enough—
Specify BTH Contactor Control.

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BRITISH THOMSON-HOUSTON
COMPANY LIMITED, RUGBY, ENGLAND

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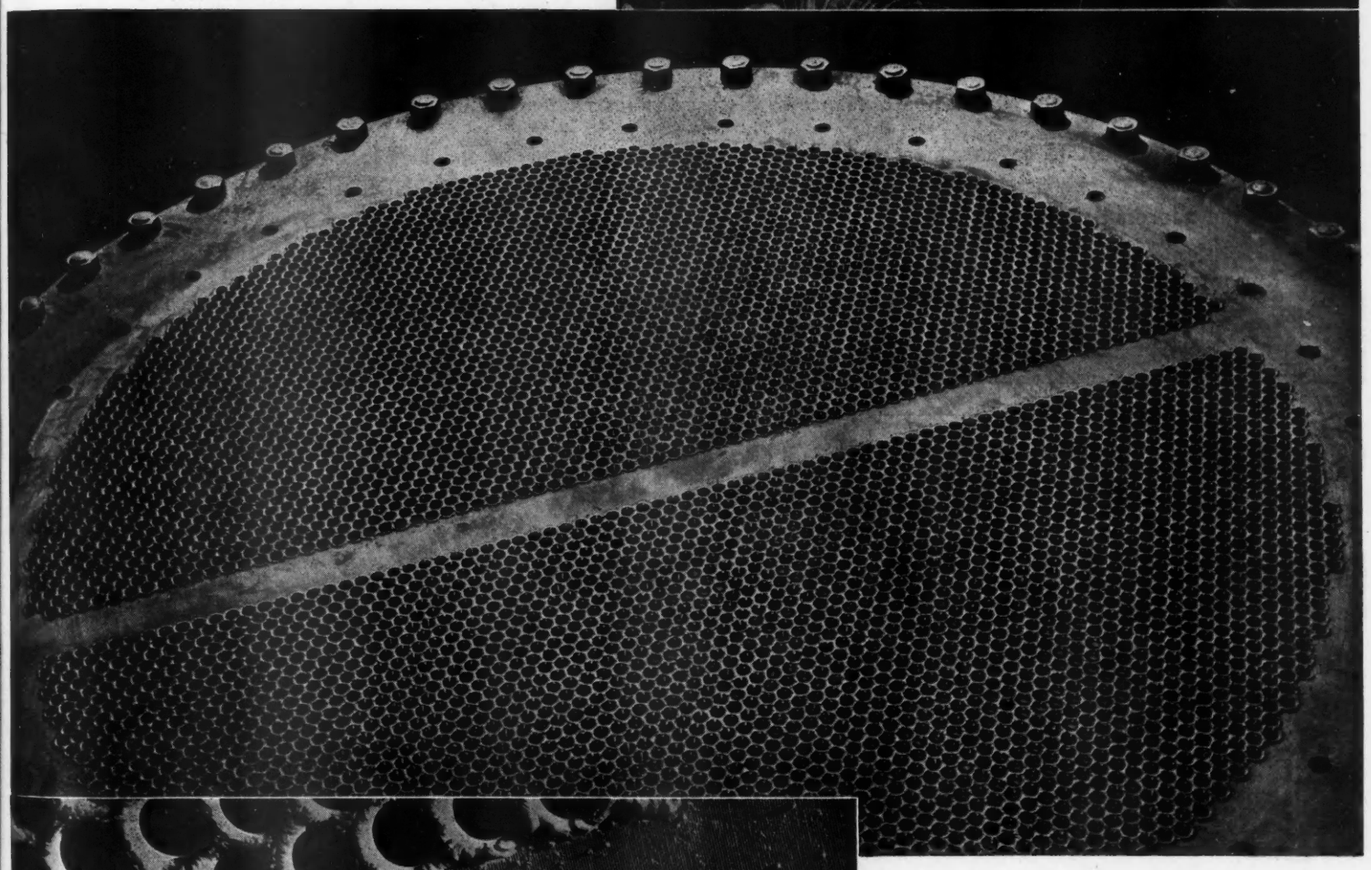

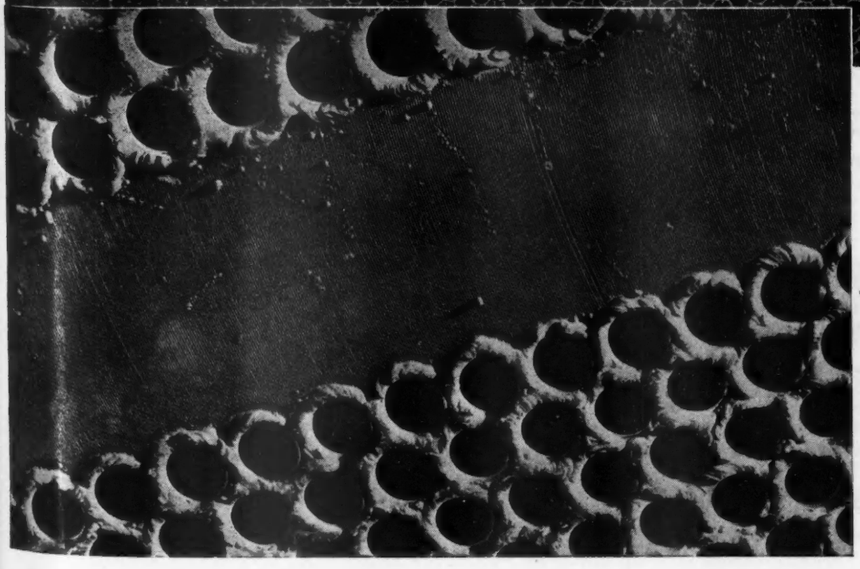

Tube plate for a Heat Exchanger, incorporating 5518 tubes ¾ in. dia., and involving 1078 footage of welding.

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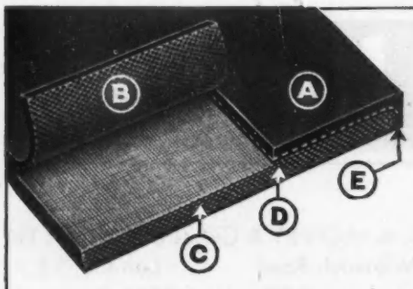

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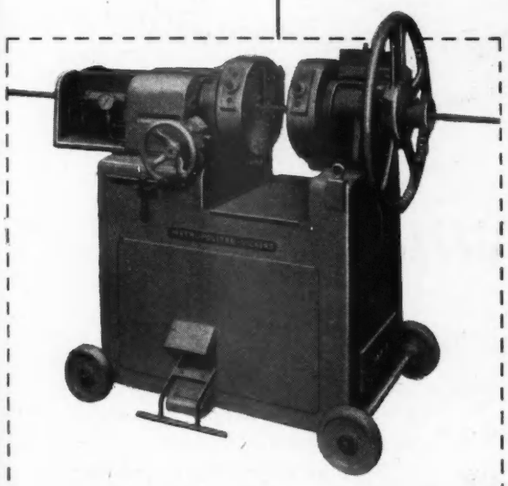
Parting...Tapering...Sealing

- all in one rapid operation

Unwound end with strands sealed ready for splicing.

Tapered and sealed conical end produced by parting machine.

It takes only 80 seconds to part, taper and seal a $\frac{3}{4}$" diameter wire rope using the *Metrovick HRP* 25 parting machine, which now incorporates hydraulically applied tension. Ropes prepared in this way are easier to thread and much safer to handle than ropes with bound ends. When the end is to be used for splicing, the individual strands can be sealed without welding the whole together.



The Metrovick parting machine can be used for continuous operation with wire ropes of $\frac{3}{8}$" to 1" diameter, and for non-continuous operation up to $1\frac{1}{8}$" diameter. Slotted clamping heads save time and trouble by dispensing with the need for threading the rope through the machine.

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

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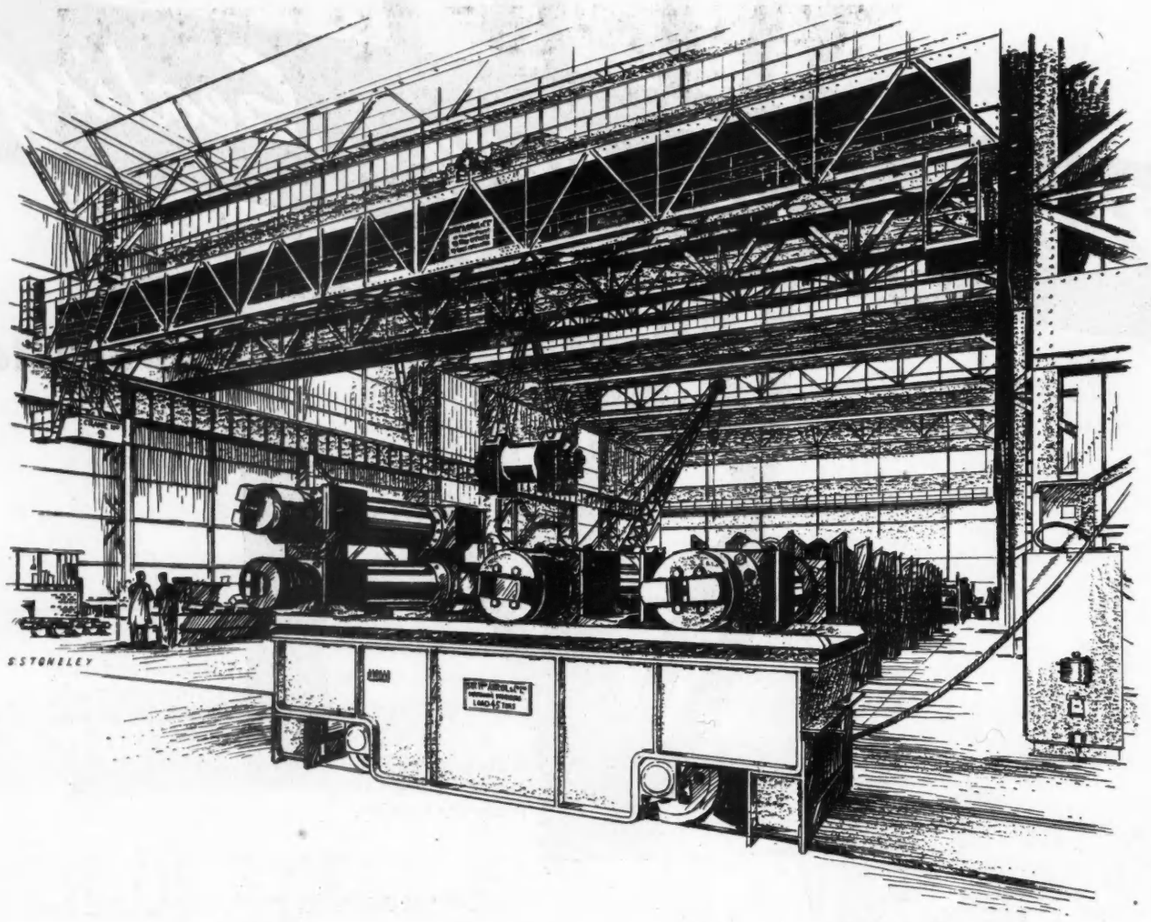
Rope Parting Machines

L/W 504

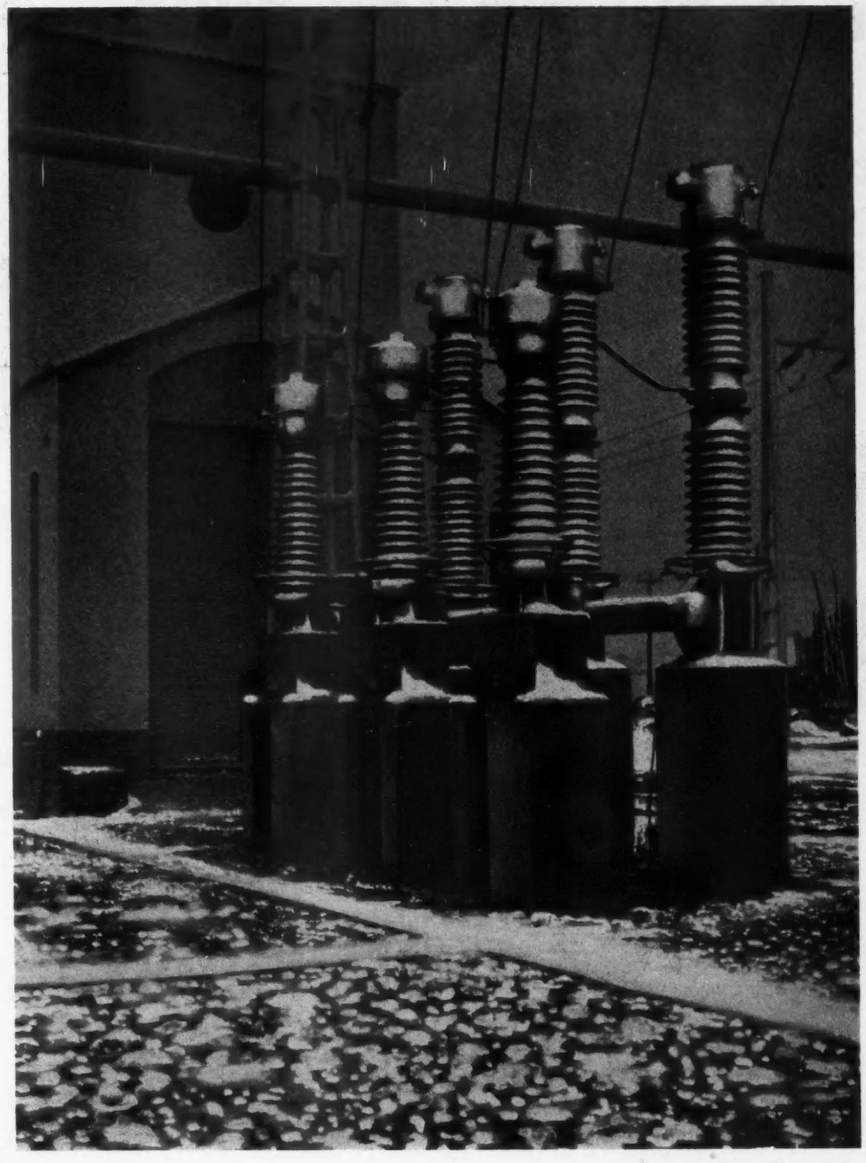


Structures / Symbols

It is a matter of national pride that the qualities which have created the world-wide reputation of British steel are the sum of combined efforts, large and small, of individuals and of corporations. Outstanding among the latter is ARROL of GLASGOW —who make a noteworthy contribution to this major British industry in the design, fabrication and erection of mechanical handling plant for modern steel works.

All types of cranes for steel works, forges, foundries; bunkers and storage bins, steel framed buildings and other steel structures; mechanical engineering work; H.P. hydraulic pumps; hydraulic presses and motors.

SIR WILLIAM ARROL & CO LTD GLASGOW Arrol



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Reyrolle small-oil-volume circuit-breakers remain reliable under all variations of climate and temperature

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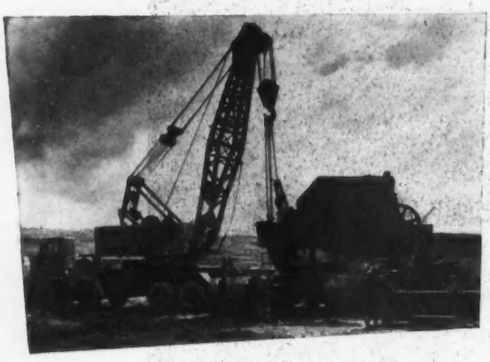
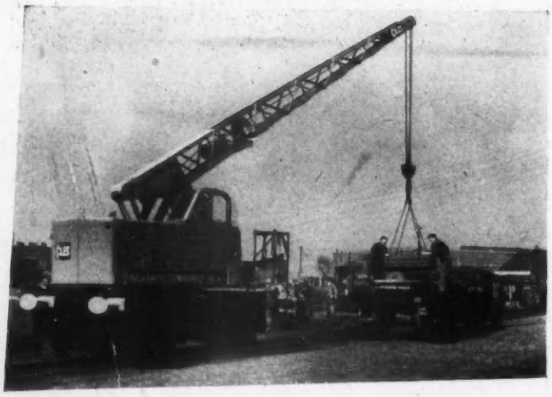


THAN JUST THE LOAD



There's much more to mobile handling than mere weight-lifting. Crane performance embraces manoeuvrability, ease of control, good vision, safety and so on. These factors make all the difference in handling a load. So there's nothing easy in buying a crane — questions must probe every aspect of the design before the buyer is sure that he's got the right answer. More often than not, that answer is Coles — unbeaten for power, speed and low maintenance. The search for *your* mobile crane is not over until you've seen the Coles.

A wide range is available in capacities up to 92,000 lb. Details will be sent on request.

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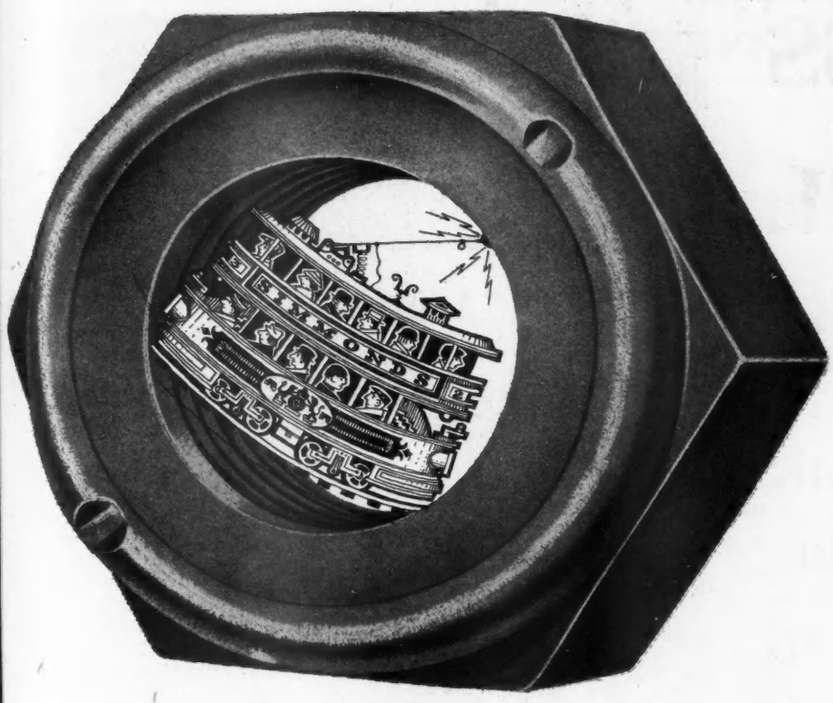
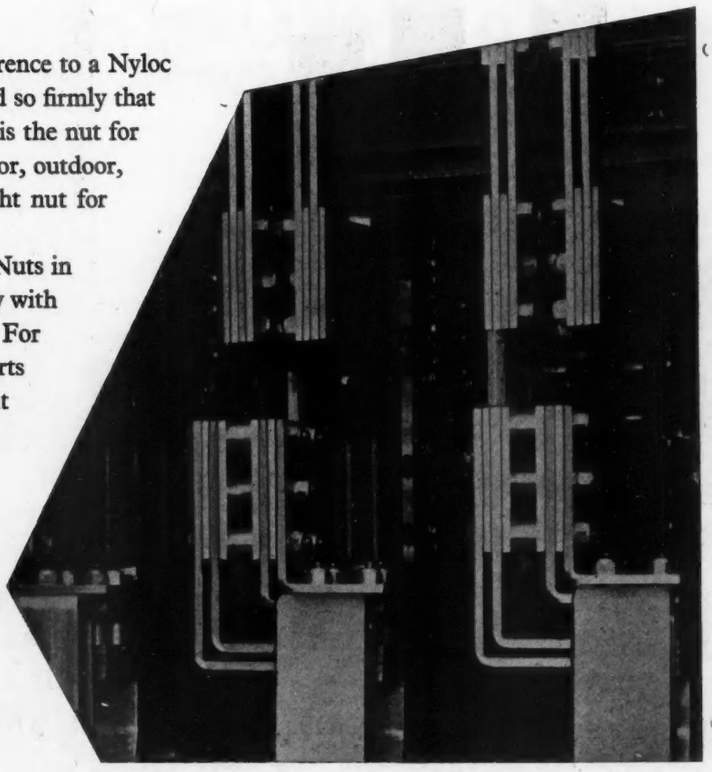


. . . but nothing shocks the NYLOC

24-volt or 232,000-volt Switchgear—it makes no difference to a Nyloc self-locking nut. The nylon insert grips the bolt thread so firmly that nothing (except a spanner) can disturb it. The Nyloc is the nut for any type of switchgear—oil immersed, air break, indoor, outdoor, contactor gear or flameproof equipment: it's the right nut for *any* location where a normal nut would work loose.
George Ellison Limited have found that using Nyloc Nuts in the assembly of their distribution switchgear does away with the need for constant inspection and maintenance. For example, they use 200 $\frac{3}{8}$" Nylocs on the busbar supports and contact assemblies of every 3,000 amp. circuit breaker. Equally tenacious are our Fibre Nuts and Pinnacle Nuts. We'll be glad to advise you which type of self-locking nut is best for your purpose.



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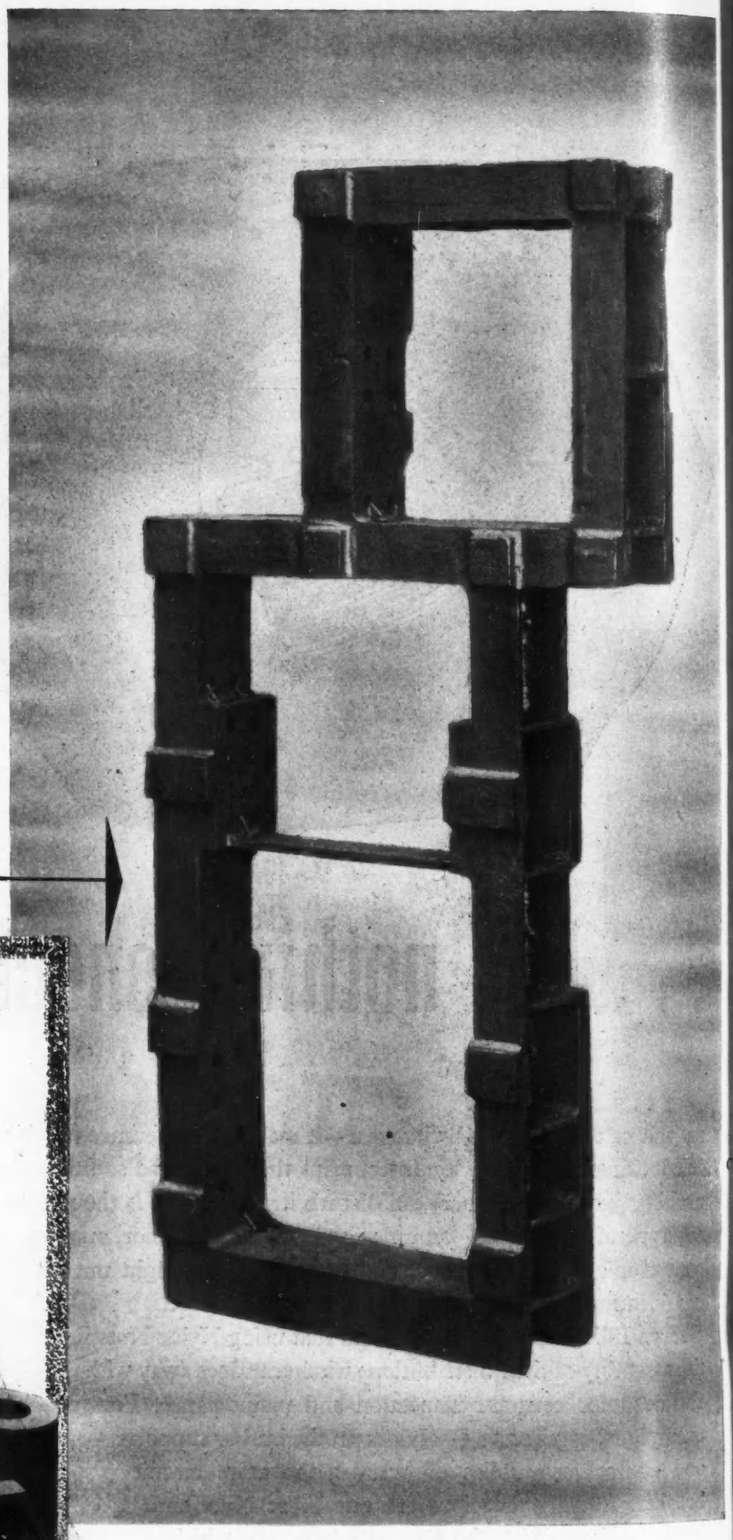

From over one ton to under one ounce

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PRODUCERS OF ALLOY STEEL AND NON-FERROUS CASTINGS

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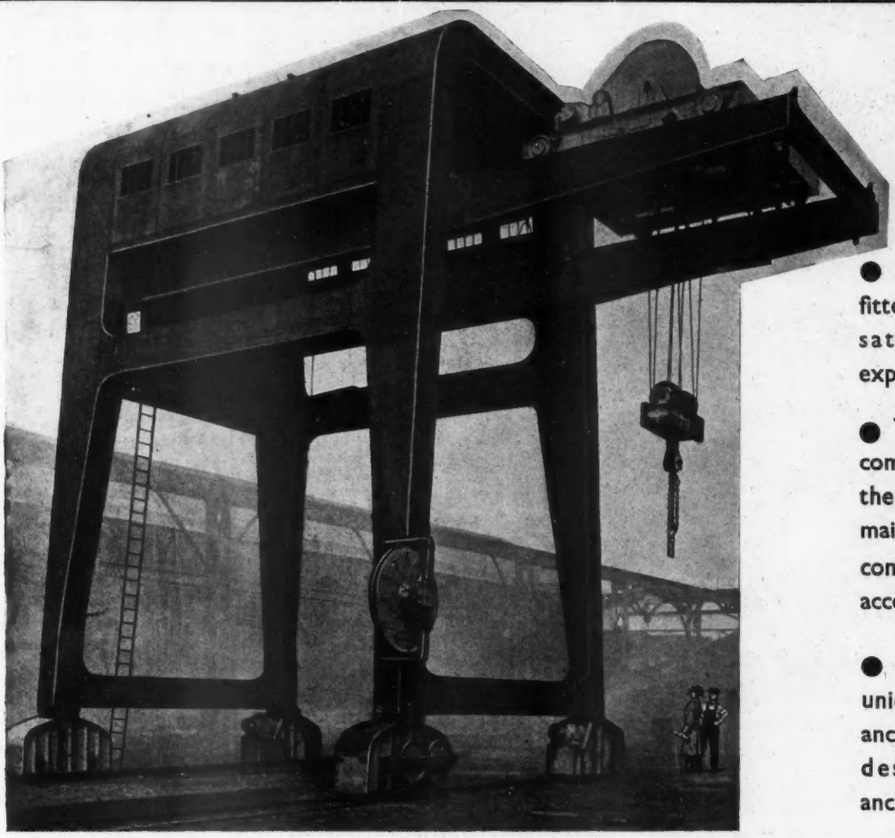
GOLIATH *TRAVELLING GANTRY CRANE*



● The structure is of all-welded box plate construction throughout. This gives an exceptionally strong rigid frame.

● A twin motor travel drive is fitted which incorporates compensating bogies and internal expanding brakes.

● The structural lay-out gives complete weather protection to the crab ; particularly useful for maintenance purposes as all the components on the crab are easily accessible.

● The whole design gives a unique, pleasing external appearance in harmony with the modern design of the Dam and its ancillary buildings.

CHOSEN BY THE NEW ZEALAND M.O.W. FOR THE ROXBURGH POWER PROJECT

This 30-ton Goliath Travelling Gantry Crane is installed on the Dam of the Roxburgh Power project. This project is approximately 100 miles from Port Chalmers on the South Island of New Zealand.

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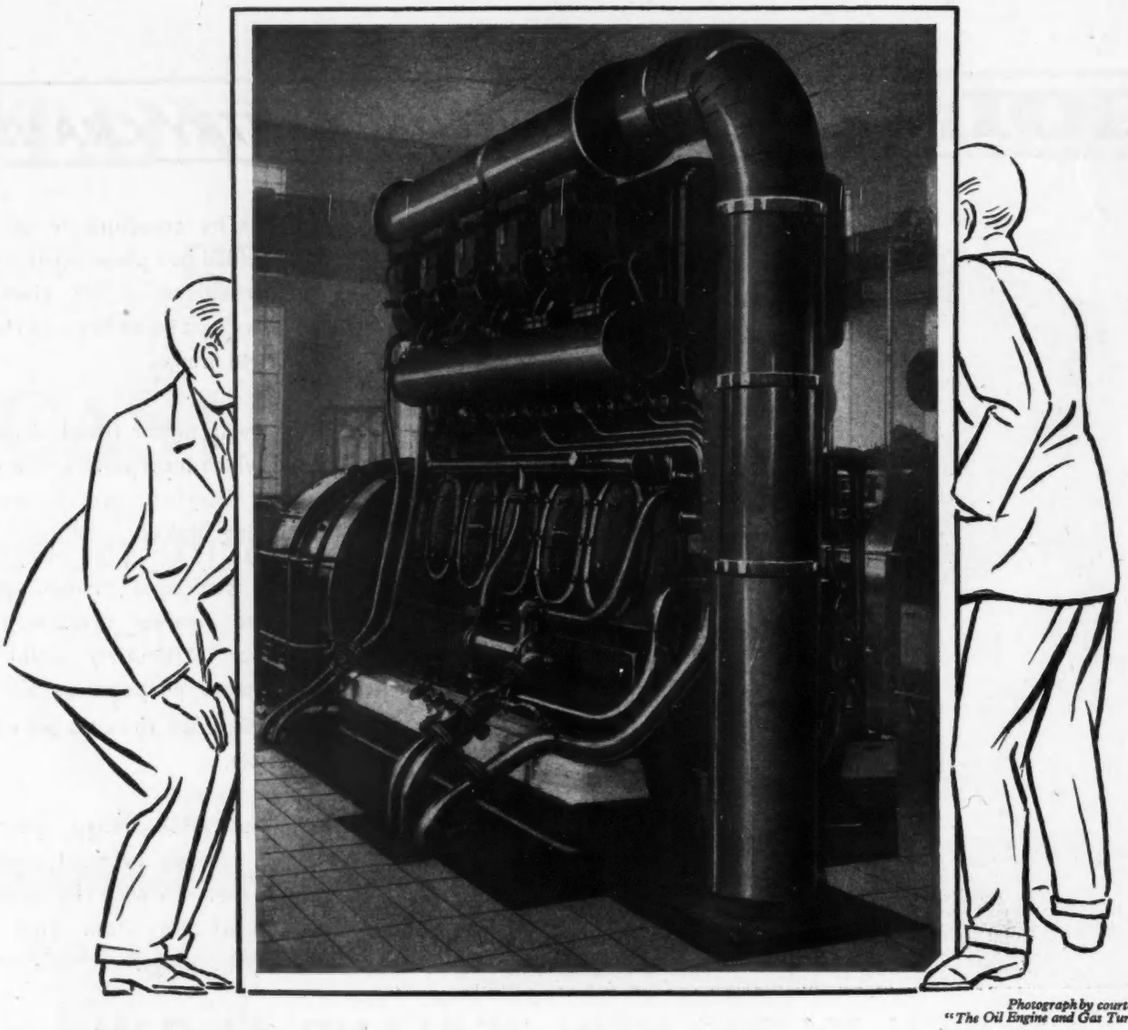

Photograph by courtesy of "The Oil Engine and Gas Turbine"

But what's behind this picture?

"Yes," said the visitor, "it all looks very efficient—very efficient indeed. Gleaming machinery and spotless walls and floors always do. But that's only half of it. What about the other side of the picture? What about all the hours of labour involved in cleaning and degreasing? And the cost of it? Labour's not easy to get, you know. I'd like my own factory to look like yours, but frankly I can't afford it—and I can't spare the time!"

But of course, the visitor's education has been sadly neglected. He should use Gunk. With Gunk working for you it is easy and inexpensive to keep your factory clean. Gunk removes oil and grease as if by magic—just brush it on and rinse it off with cold water and all traces of oil and grease have disappeared in less time than it takes to tell. Yes, Gunk is the answer to all degreasing problems. It is fast and safe and foolproof. It needs no bothersome preparation either. You can use it straight from the tin.

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Send for Sample to the Sole Manufacturers:

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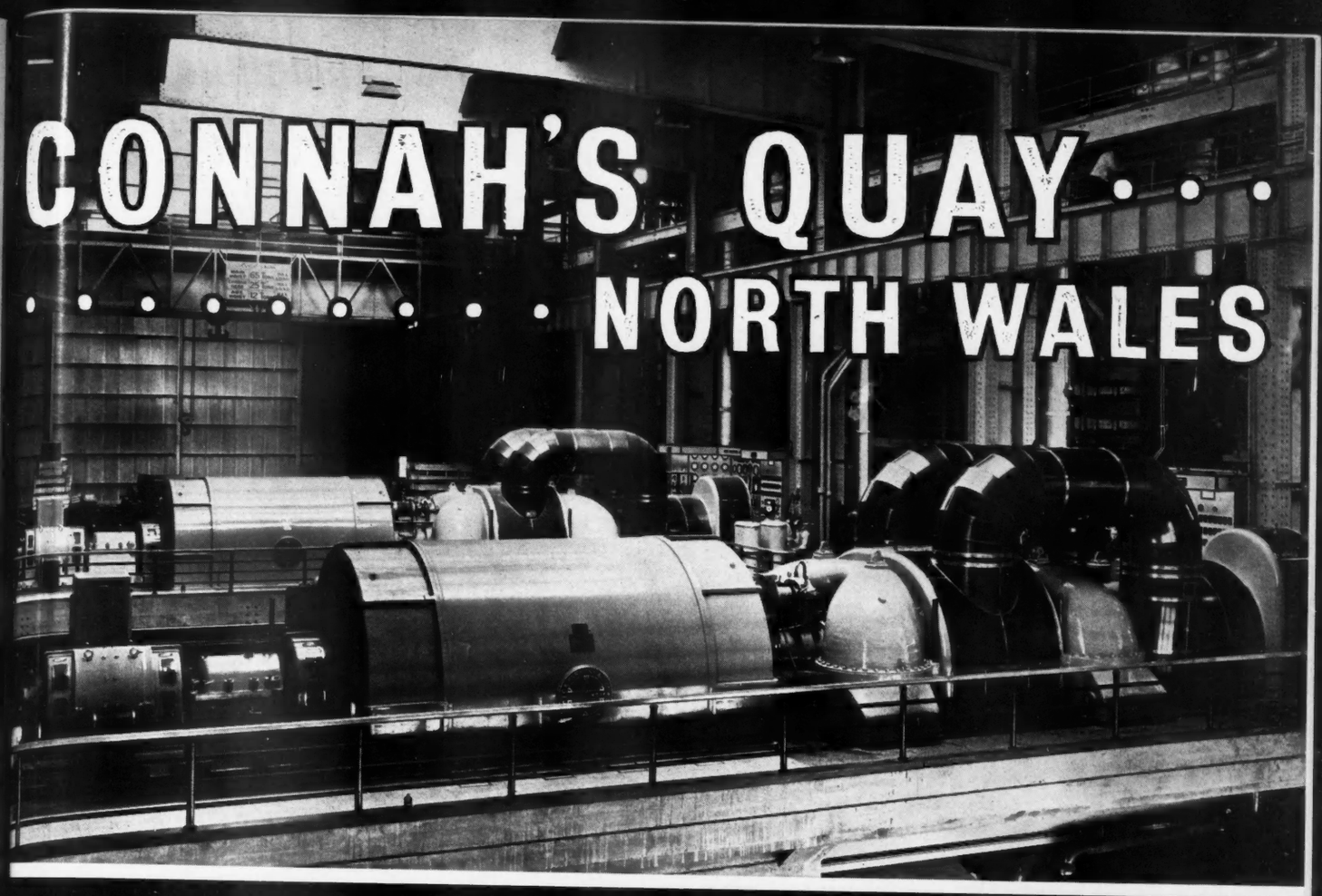
Telephone: Hyde 1377



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Another chapter in the production story of Chemical Plant

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The photograph in this advertisement illustrates another chapter in the production story of T.B. welded fabrication for Chemical Plant and other industries. For over half a century our high engineering skill and craftsmanship in this field has been unswervingly maintained while the scope and volume of output have progressively developed until today the diversity of our production ensures a service which is undoubtedly second to none.

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PERFORMANCE SPEEDS EARTHMOVING ON THE SITE

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DESIGNED AND BUILT BY VICKERS-ARMSTRONGS

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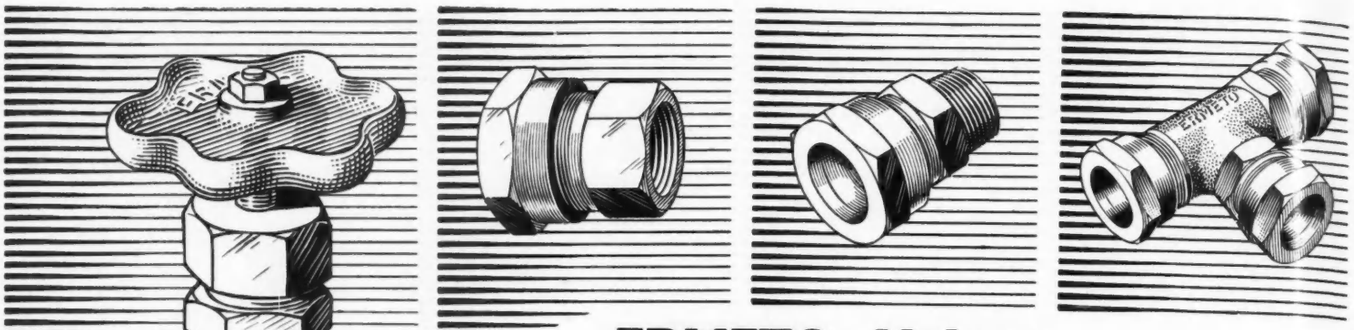

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are unequalled for ease of application and pressure tightness. Approved by the Admiralty, Ministry of Supply, Lloyds and the Board of Trade.

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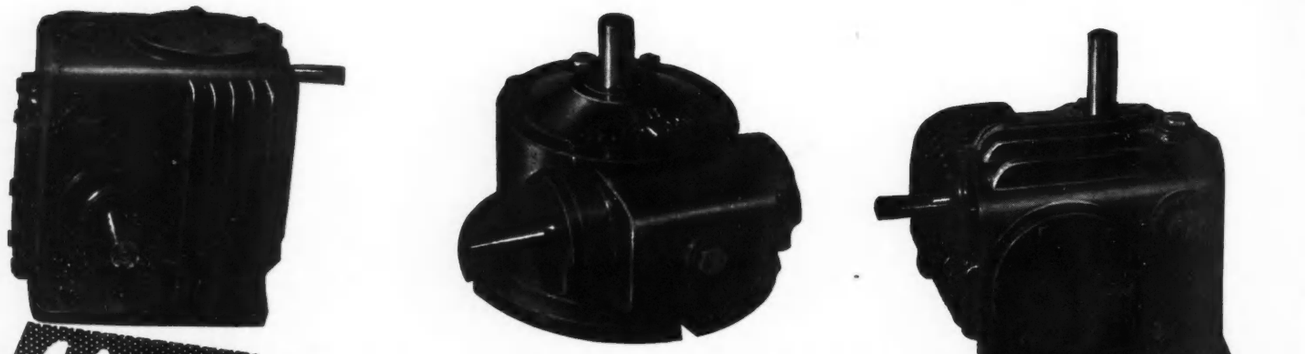

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Four Yarrow pulverised fuel fired boilers are installed at this 120 M.W. Station. Each has a C.M.R. of 300,000 lb. of steam per hour at a pressure of 625 lb. per sq. inch and a final steam temperature of 865°F.

Yarrow and Co. Ltd have been designing and manufacturing Water Tube Boilers for almost seventy years and are fully equipped to supply complete steam generating plant in a range of designs and sizes to suit any operating conditions.

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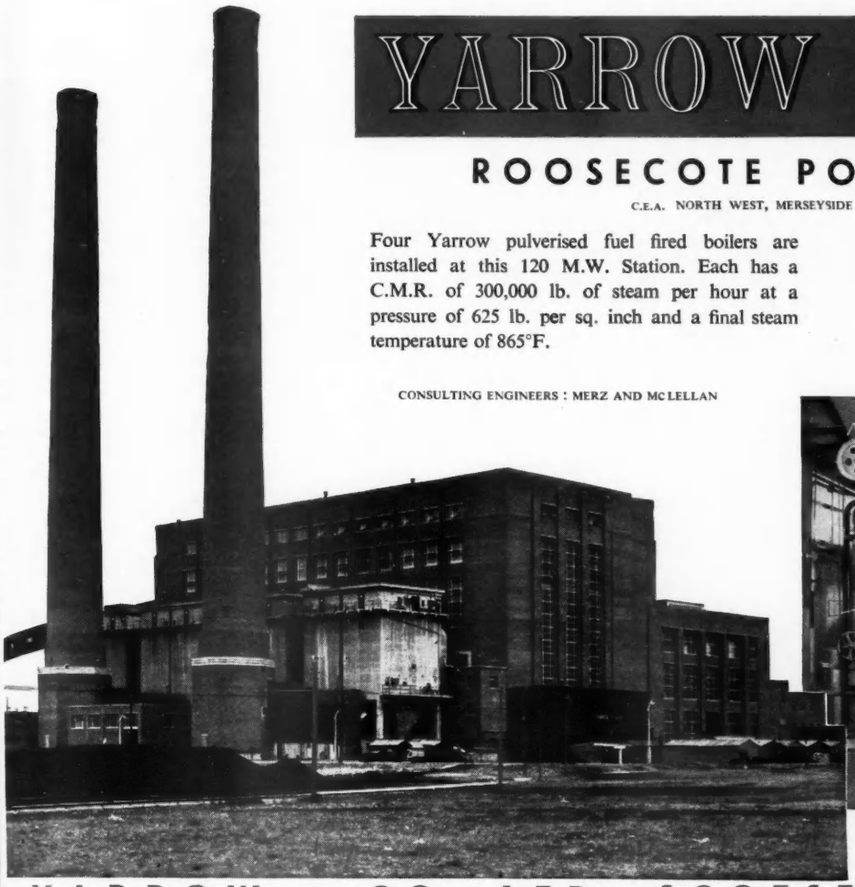

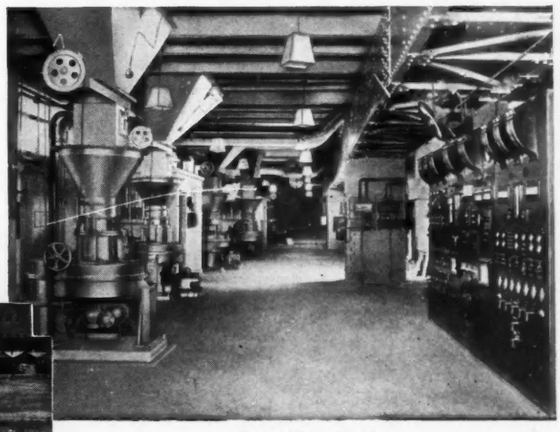

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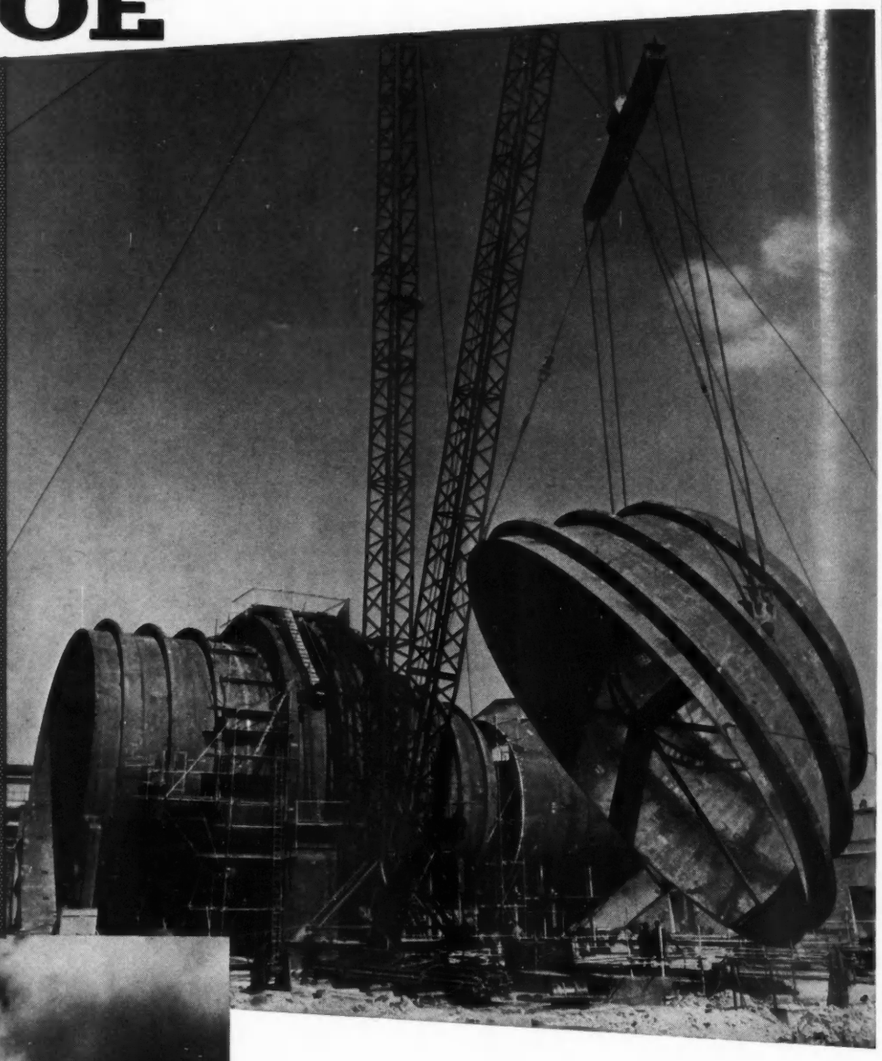
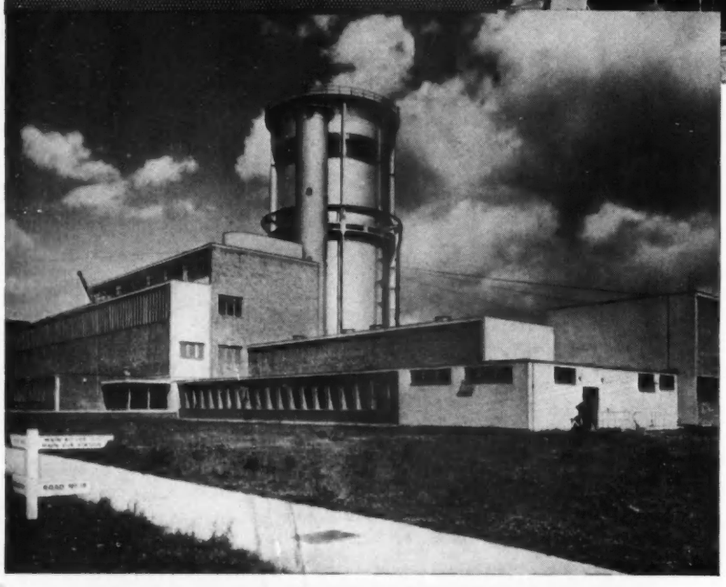
built the major WIND TUNNEL STRUCTURES in steel plate for the NATIONAL AERONAUTICAL ESTABLISHMENT at Bedford





Transonic and Supersonic Tunnel
Mach 0.9 to Mach 2

Vertical Spinning Tunnel
Pressures to 4 atmospheres

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Mach 2.7 "The largest all-welded pressure vessel in Europe"—vide 'Engineering' 18th February, 1955.

The designs were by Whessoe in conjunction with the Ministry of Works and the National Aeronautical Establishment. Manufactured in steel plate, erected and welded throughout by Whessoe Ltd.

WHESSOE Design and Construction in *Steel Plate*

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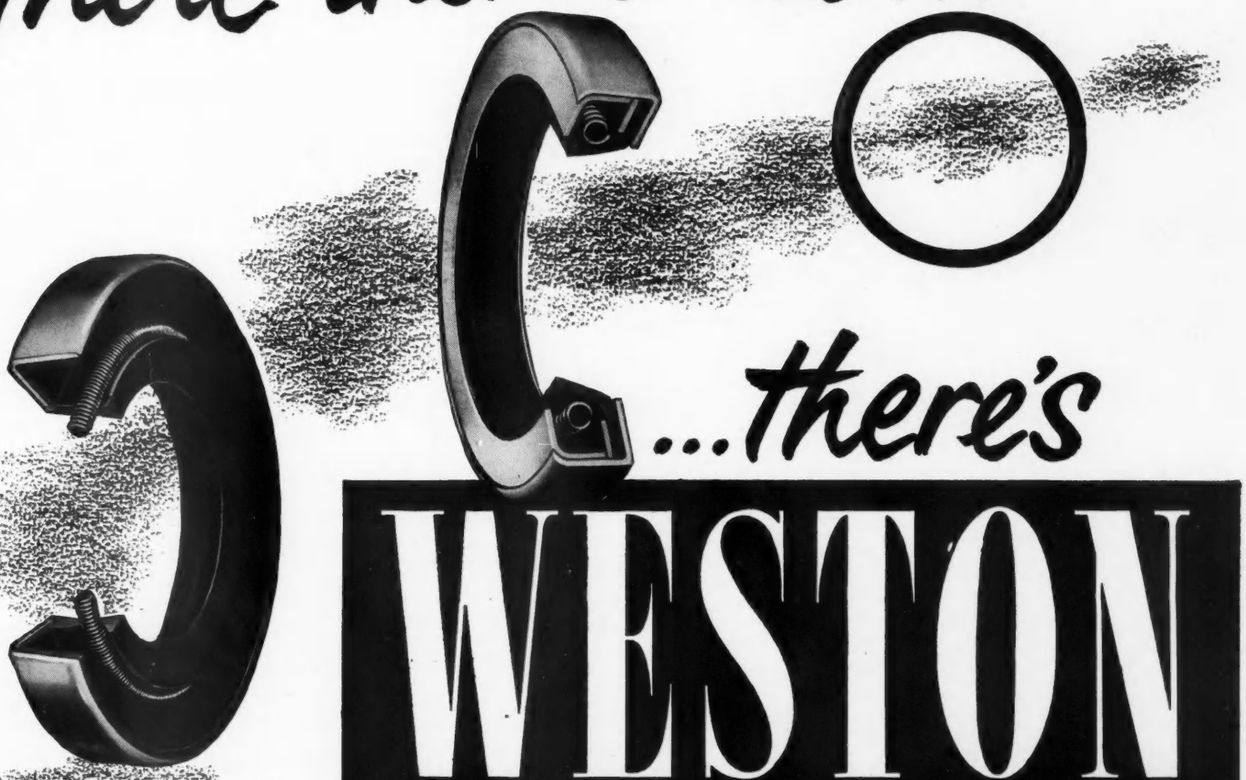

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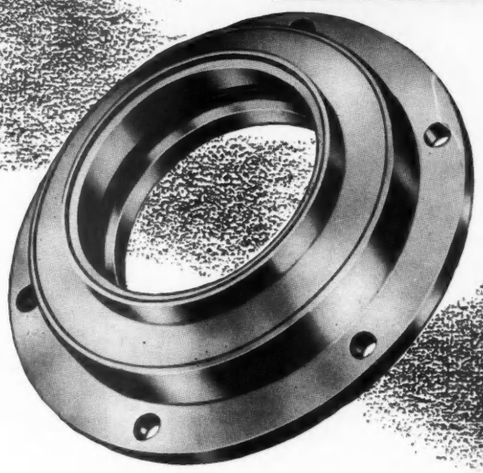
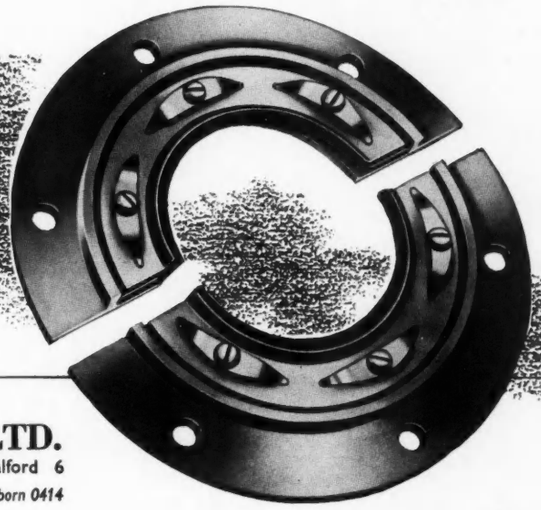
Weston Oil Seals and 'O' Rings protect and enhance the performance of almost every kind of mechanical equipment and under almost every condition throughout the world. They are vital parts of equipment which have to retain lubricants and keep dirt and water out.
21 years' experience is at your disposal.





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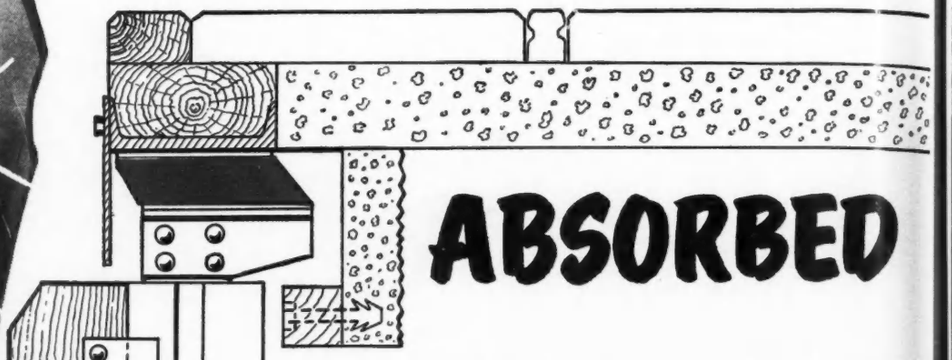
...Who serve you well!

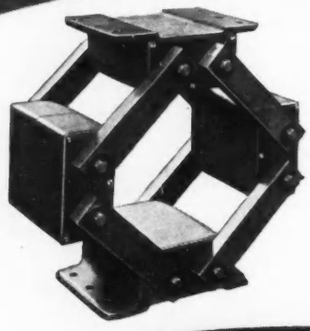


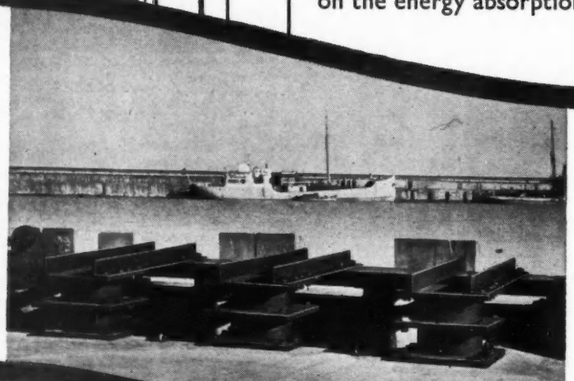
ABSORBED

Andre rubber-metal bonded springs are designed to absorb very heavy shock loads such as are encountered by the fenders on jetties and wharves. These springs take the form of "sandwiches" in which the rubber is bonded to a top and a bottom metal plate. One plate will move relative to the other under shock conditions to a maximum of 45°.

A spring in which the rubber is 9" in diameter by 3" thick will absorb energy of 6 inch-tons when deflected 45°, while one measuring 21" diameter by 6" thick has a maximum energy absorbing capacity of 75 inch-tons.

The springs can be employed in series or in parallel, depending on the energy absorption required.





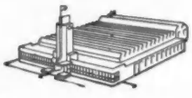
Centre: A view of the fenders at the Dover Harbour Board's Car Ferry Terminal showing how the Andre springs are fitted in pairs, one on top of another.

Left: An Andre-Neidhart fender pile spring unit. A number of these units which take loads in any direction and have a very high energy absorption have been fitted to The Regent Oil Co's Coaster Jetty, Canvey Island. (*Consulting Engineer: J. H. R. Haswell, B.Sc., M.I.C.E.*)

Andre RUBBER

ANDRE RUBBER

Three acres of specialised Rubber Technology.



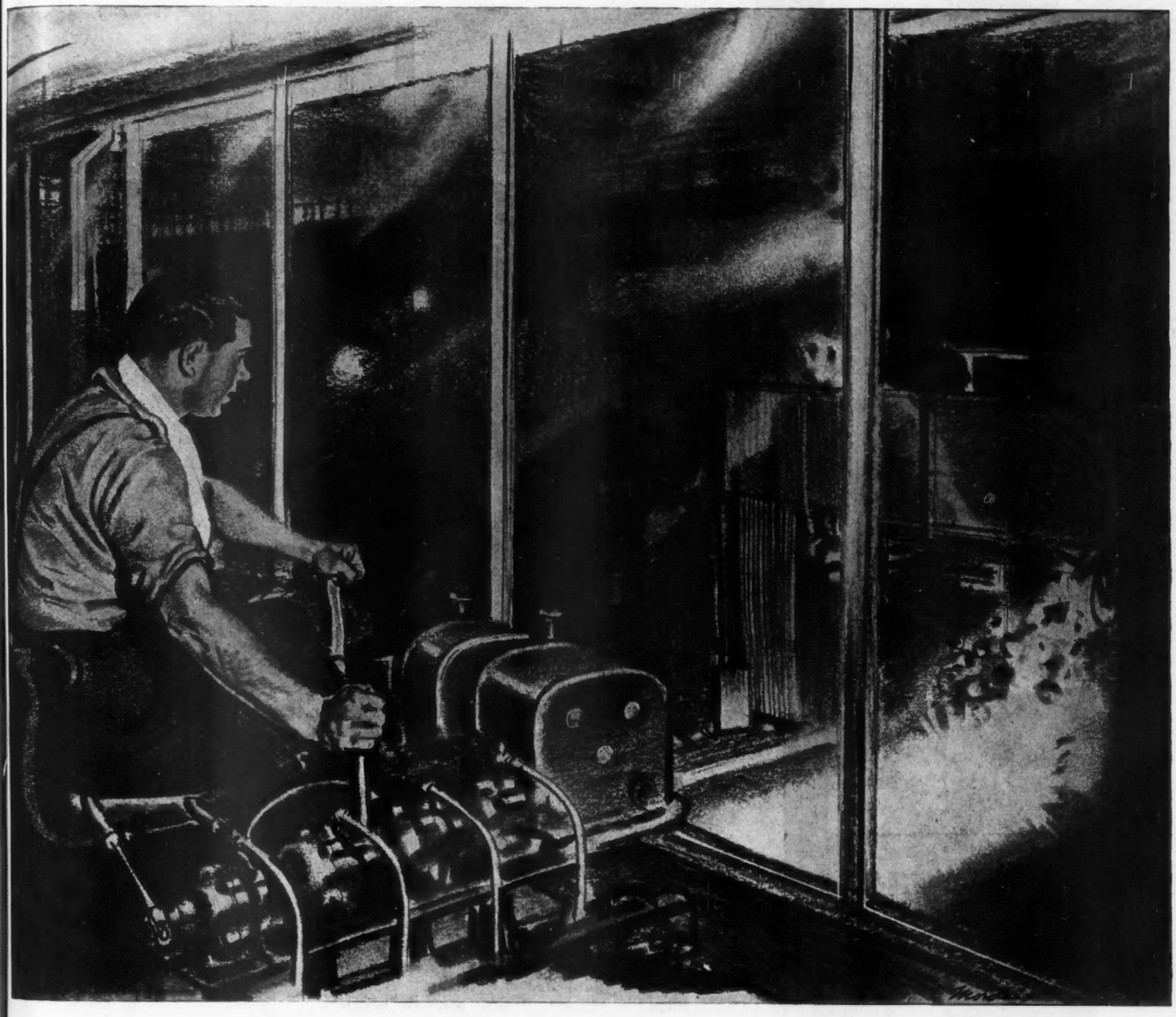
ANDRE RUBBER COMPANY LIMITED

(A SILENTBLOC COMPANY)

KINGSTON BY-PASS, SURBITON, SURREY

Telephone: Elmbridge 6580/3. *Telegrams: Andre, Surbiton.*

protect him with "ARMOURPLATE" GLASS



The operator in this steel mill is safe. He is protected from heat and splashes of molten metal by "ARMOURPLATE" glass, and where vision is essential there is no more efficient protective material. "ARMOURPLATE" allows the machine operator to see exactly what he and the machine are doing without letting him run the slightest risk. It helps to build up his confidence and provide the sort of working conditions that bring optimum results in output figures.

As a long-term investment, "ARMOURPLATE" glass is often a necessary item of capital equipment.

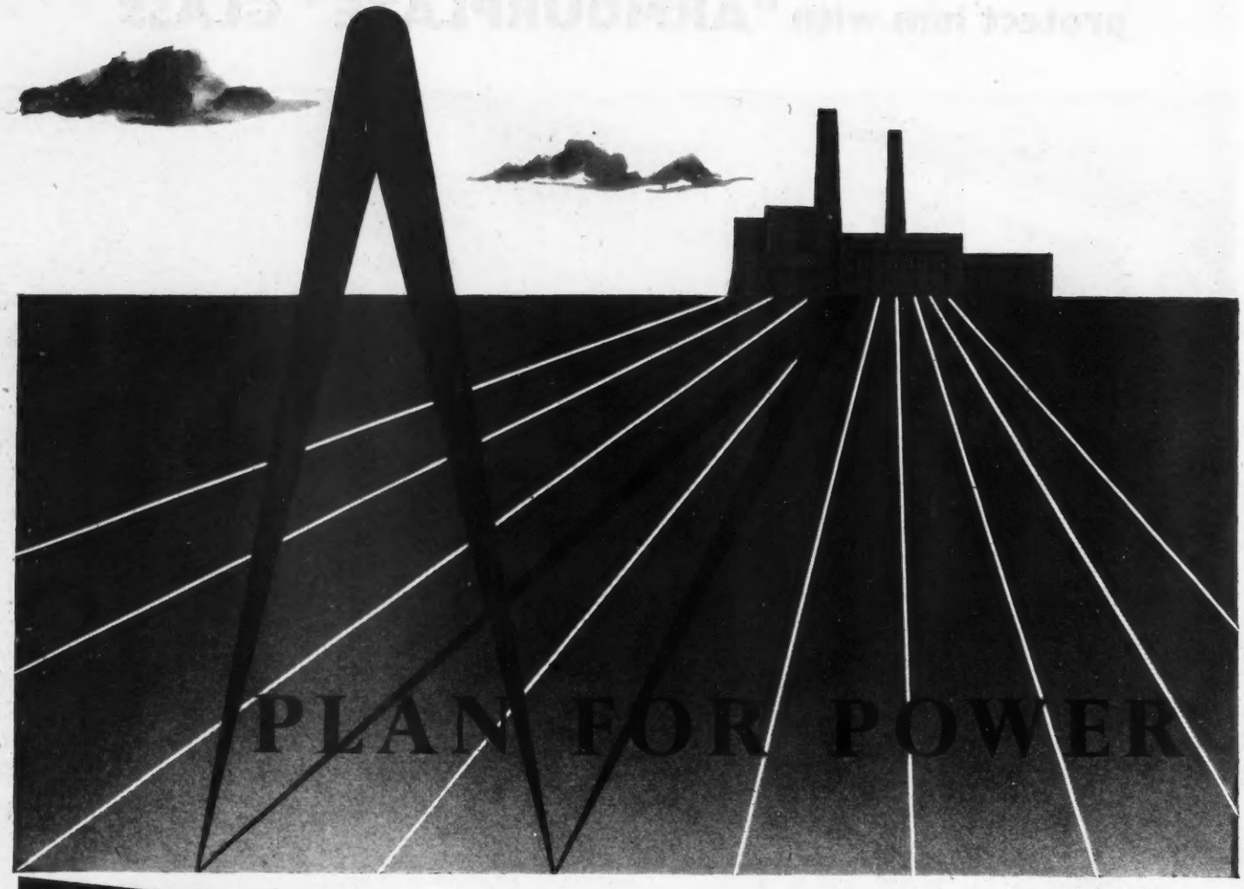
"ARMOURPLATE" GLASS

for a clear, safe view of the job

L.14.

PILKINGTON BROTHERS LIMITED

CONSULT THE TECHNICAL SALES AND SERVICE DEPARTMENT, ST. HELENS, LANCS; (ST. HELENS 4001); OR SELWYN HOUSE, CLEVELAND ROW, ST. JAMES'S, LONDON, S.W.1. (WHITEHALL 5672-6). *Supplies are available through the usual trade channels. "ARMOURPLATE" is a registered trade mark of Pilkington Brothers Limited.*



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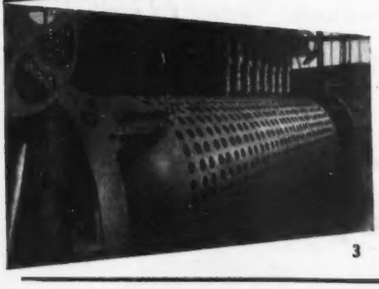


3

WE ARE PREPARED to assist and advise on steam generating plant requirements for power stations, paper mills, steelworks, collieries, cement mills and other industrial undertakings in the British Isles and abroad. Each installation receives individual attention and is designed to meet any requirements peculiar to the working conditions. Our orders vary over a range of 5,000 to 550,000 lbs. of steam per hour, and are designed on the latest modern practice, suitable for high pressures, heavy duties and the highest efficiencies.

Water-tube boilers and ancillary equipment. Raymond Bowl and "Resolutor" Milling Plant · Fusion welded pressure vessels Erection winches · Ash conveyors

1. Power expanding of tubes inside a boiler drum.
2. One of two Raymond Bowl Mills and exhauster fans firing one water-tube boiler.
3. Multiple spindle machine trepanning tube holes after fabrication.

WATER-TUBE BOILERS BY *Clarke Chapman*

CLARKE, CHAPMAN & CO. LTD. VICTORIA WORKS, GATESHEAD 8, CO. DURHAM

Telephones: Gateshead 72271 (10 lines). Telegrams: "Cyclops" Gateshead.

London Office: Dunster House, Mark Lane, London, E.C.3. Telephone: Mincing Lane 8345/6/7

cuts breakdowns, cuts wear, cuts costs

Norgren "Oil-Fog" and "Micro-Fog" Lubricators produce a fine, penetrating oil-fog which, reaching the working parts of air-operated equipment, ensures correct lubrication. Wear is thus reduced and performance improved.

For air tools, air cylinders, and other air operated mechanisms

For bearings, gears, chains, etc.

The new Norgren Model 30-41-2S "Micro-Fog" Lubricators are specially designed for reliable uniform lubrication of one or more high-speed spindles, bearings, gear-boxes and similar equipment. The uniformly fine oil-fog does a better lubrication job and being airborne, maintains lower operating temperatures. Lubricant is conserved and air pressure in bearing and gear housings prevents entry of foreign materials.

For machining operations

Norgren "Mist-Cool" gives cooling lubrication where you need it. Airborne coolant is delivered direct to the cutting area and from any angle that best reaches the critical points. Increased tool life, better finish and reduced coolant consumption are possible on tapping, drilling, milling, turning, boring and many other machining operations.

Compressed Air Filters, Regulators, Oil-Fog and Micro-Fog Lubricators

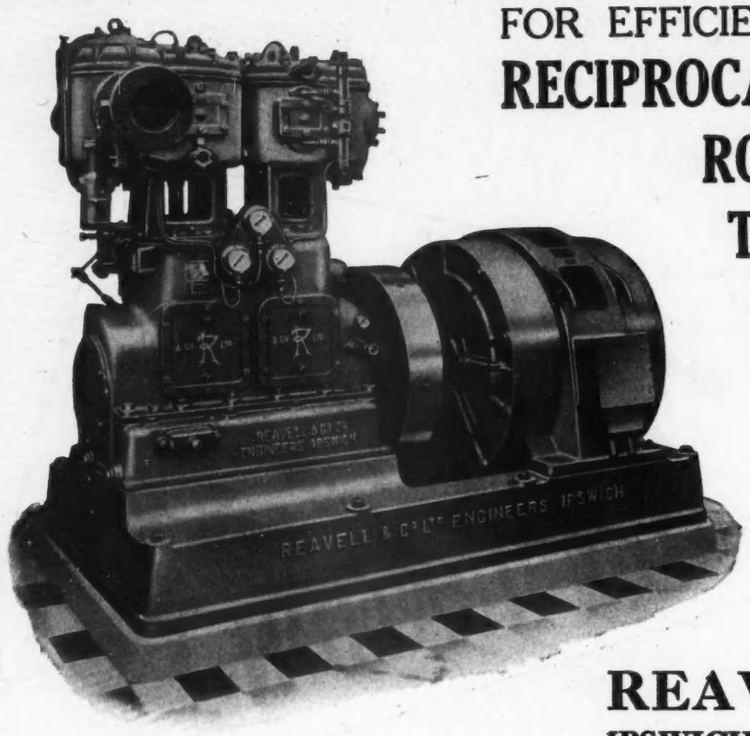
For full details, write to :

C. A. NORGREN, LTD., SHIPSTON-ON-STOUR, WARWICKSHIRE. TELEPHONE : 110 and 106

MW.116

SPECIFY "REAVELL"

FOR EFFICIENCY AND RELIABILITY



RECIPROCATING COMPRESSORS
ROTARY COMPRESSORS
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PRESSURES FROM
1 TO 10,000
LBS. PER SQ. INCH
FOR
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REAVELL & CO. LTD
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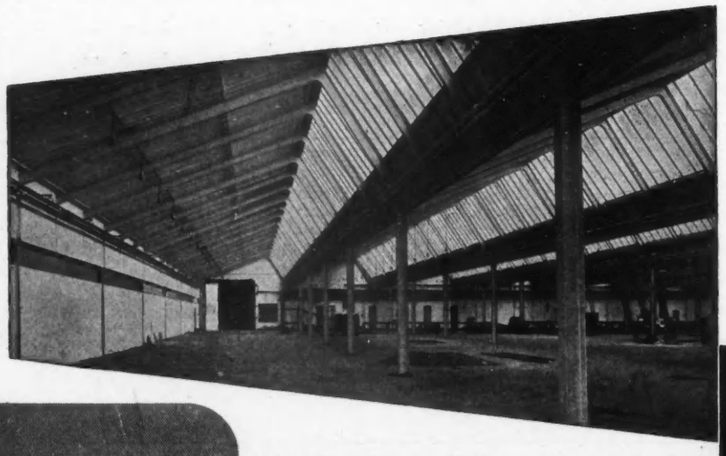
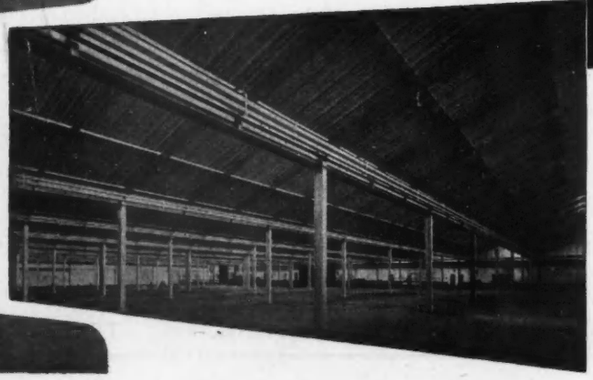
Telegrams: Reavell, Ipswich. Telephone Nos. 2124-5-6



New Factory at Barnsley for Brook Motors Ltd.
Architect: Noel Heppenstall, L.R.I.B.A.,
Milnesbridge, Near Huddersfield.

Structural Steelwork by AUSTINS



JAMES AUSTIN & SONS
(Dewsbury) LTD
THORNHILL IRON & STEELWORKS
DEWSBURY • YORKSHIRE
Phone: 1750 (7 lines) • Grams: Austins Dewsbury

TRADE MARK
EST. 1850

Castings by Carron...

This large Planing Machine contains approximately 112 *tons of iron castings, all of which were made in Carron's Heavy Foundry. The castings include: Table,* 21 *tons; Uprights (two),* 11 *tons each; Cross Slide,* 9 *tons; Centre Bed,* 21 *tons; Extension Beds (two)* 12 *tons (total); and other castings,* 27 *tons approx. The machine was made for export to India and will deal mainly with locomotive cylinders. (Photo by courtesy of Scottish Machine Tool Corporation Ltd., Glasgow.)*

CARRON

HEAVY FOUNDRY

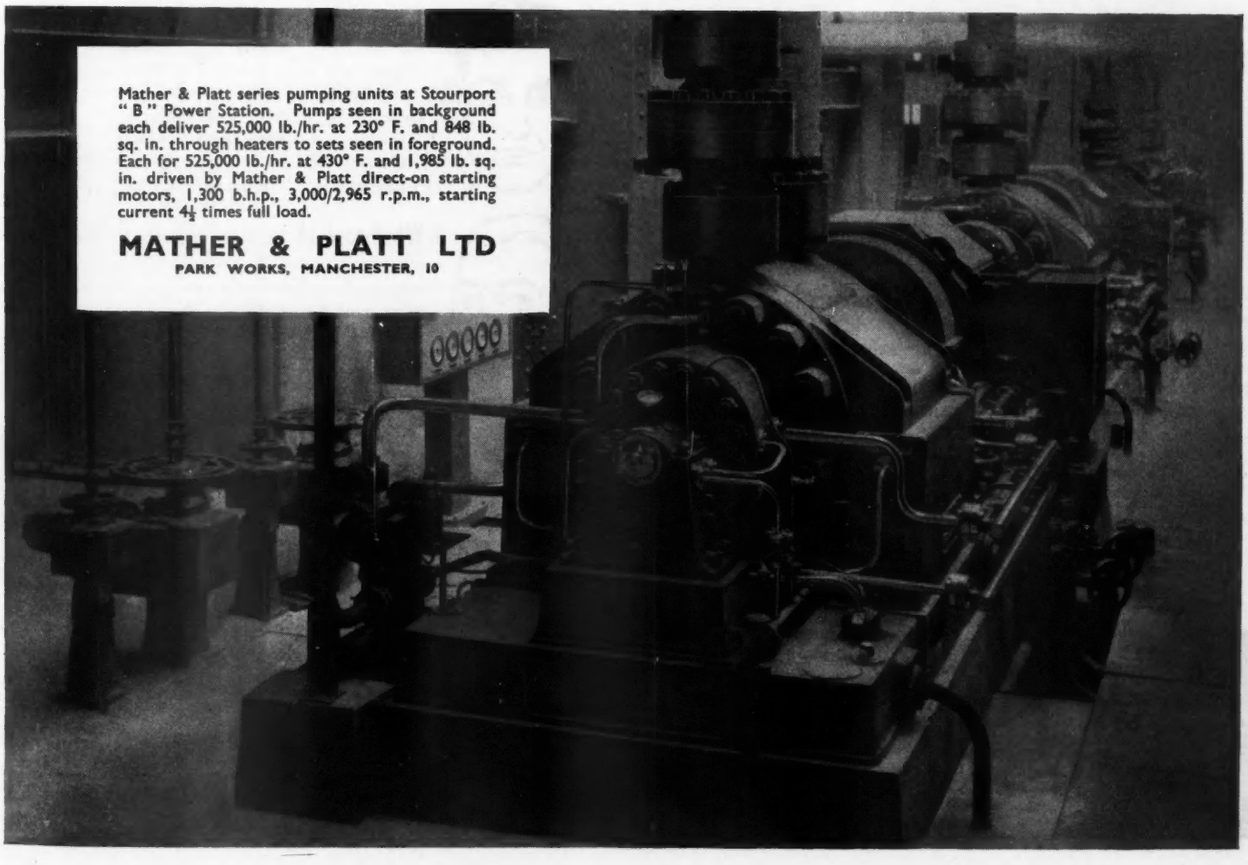
Carron's Heavy Foundry produces high-class castings up to 40 tons in weight for leading manufacturers of machine tools, laundry and sugar machinery, and chemical and general engineering plant. Castings are made in either drysand, greensand or loam; loam work is a speciality. If you have heavy casting problems bring them to Carron.

and for that General Engineering job

you can always count on first-class work from Carron Engineering Department

CARRON COMPANY · CARRON · Falkirk · STIRLINGSHIRE

D28



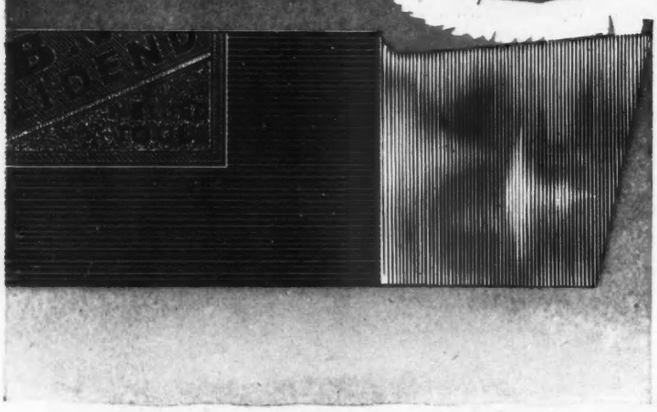
Mather & Platt series pumping units at Stourport "B" Power Station. Pumps seen in background each deliver 525,000 lb./hr. at 230° F. and 848 lb. sq. in. through heaters to sets seen in foreground. Each for 525,000 lb./hr. at 430° F. and 1,985 lb. sq. in. driven by Mather & Platt direct-on starting motors, 1,300 b.h.p., 3,000/2,965 r.p.m., starting current 4½ times full load.

MATHER & PLATT LTD
PARK WORKS, MANCHESTER, 10

S·O·B·V

CUTTING ALLOY

LATHE & PLANER TOOLS



AND WELDED BLANKS

S.O.B.V. Solidend means faster more accurate and economical cutting.

Osborn "Solidend" Tools consist of a full section of S.O.B.V. Cutting Alloy, or High-Speed Steel butt-welded on to a High Tensile Steel Shank. The weld remains unaffected by forging and heat treatment.

Users thus obtain all the benefit of a SOLID tool at a fraction of the cost. "Solidend" welded blanks are supplied for those who prefer to forge their own tools.

All standard shapes are available; special patterns and form tools made to requirements.

OSBORN

SAMUEL OSBORN & CO., LIMITED

CLYDE STEEL WORKS, SHEFFIELD

"Now, tell me this..."

"What is Ferobestos?"

Ferobestos plastics are non-metallic asbestos based materials impregnated with resins and moulded into a hard insoluble, infusible substance. It is an engineering material in its own right.

"What advantages has Ferobestos over other materials?"

Ferobestos has outstanding basic advantages :—

- High strength in proportion to weight
- High temperature resistance
- Low moisture absorption
- Good chemical resistance
- Good electrical resistance
- High wear resistance
- High dimensional stability

"How is Ferobestos supplied?"

Ferobestos plastics are usually supplied in sheets, rods and tubes, but they can also be moulded to your requirements where contour permits and where quantity justifies the cost of mould tools. All forms of machining are carried out for you where necessary.

"How are other engineers using Ferobestos?"

Engineers in all branches of industry have solved constructional problems with Ferobestos Plastics.

Here are just a few of its applications :—

Bushes · Coupling Discs · Guides · Mounting Pads
Gears · Rollers · Piston Rings · Wearing Slippers
Bearings · Compressor Blades · Thrust Washers

"What sort of service is behind Ferobestos?"

J. W. Roberts Limited, who specialise in engineering and structural applications of asbestos, have set up a new department, entirely devoted to the development of Ferobestos Technical Plastics. This ensures a prompt, efficient service to engineers and designers.

"get me J. W. Roberts Limited Ferobestos Department"

J. W. ROBERTS LIMITED,
Ferobestos Department · Chorley New Road · Lostock · Bolton · Tel: Horwich 840

engineers want elbow room

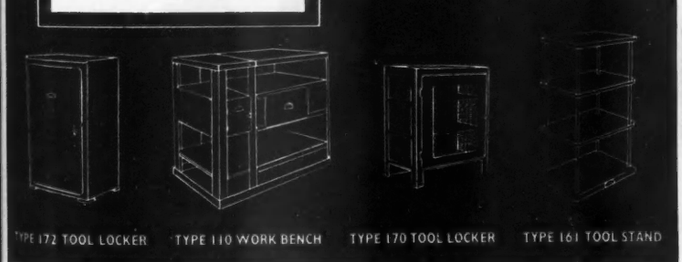
In the planned production line, every operator's station is designed to give unencumbered working space, yet easy accessibility of all tools and components—all within the smallest possible floor area. "Steelpact" Work Benches, Tool Stands and Lockers provide ample elbow room, and each unit is available in various standard forms or can be adapted to suit your particular requirements.

TYPE 165 TOOL STAND

STEELPACT

WORKSHOP FURNITURE

Write for illustrated brochure describing:— Permanent, Semi-Portable and Mobile Work Benches, Tool Stands and Lockers. Inquiries also invited for Foremen's Desks and Testing benches, Erection Trestles and other special or non-standard workshop furniture.



TYPE 172 TOOL LOCKER · TYPE 110 WORK BENCH · TYPE 170 TOOL LOCKER · TYPE 161 TOOL STAND

FAWCETT PRESTON

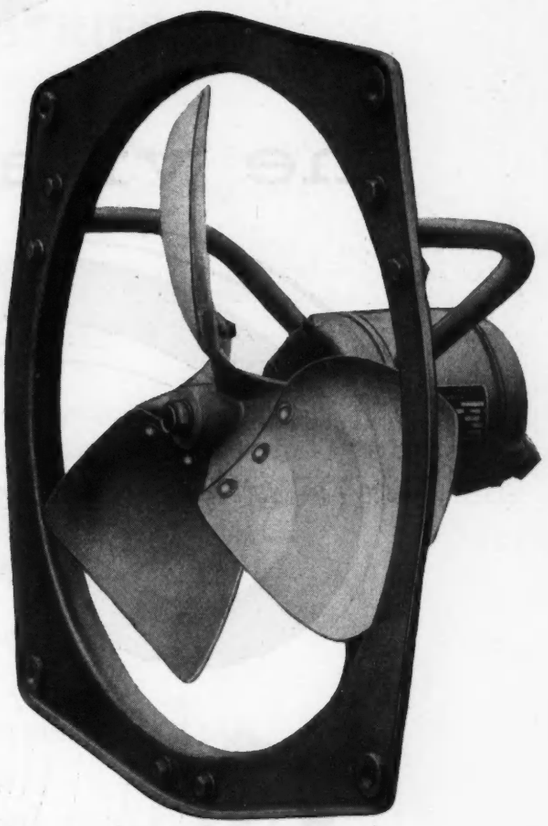
furnishers to production

FAWCETT PRESTON & CO LTD BROMBOROUGH CHESHIRE

A METAL INDUSTRIES GROUP COMPANY

M

Here is a Brand New fan range!



Known as the **type APA** this series represents the peak of achievement in design, performance and price for propeller fans working under free air conditions or against moderate resistances.

Special features of this fan, which is currently produced in 18 in. to 48 in. sizes, include

HIGH VOLUMETRIC CAPACITY
NON-OVERLOADING CHARACTERISTICS
HIGH OPERATIONAL EFFICIENCY
QUIET RUNNING · STRENGTH & RIGIDITY
ONLY THREE BLADES

These fans are included in our large range of stock machines which are always available.

Write now for the newly published BOOKLET No. 32/2 giving full details of the APA range.

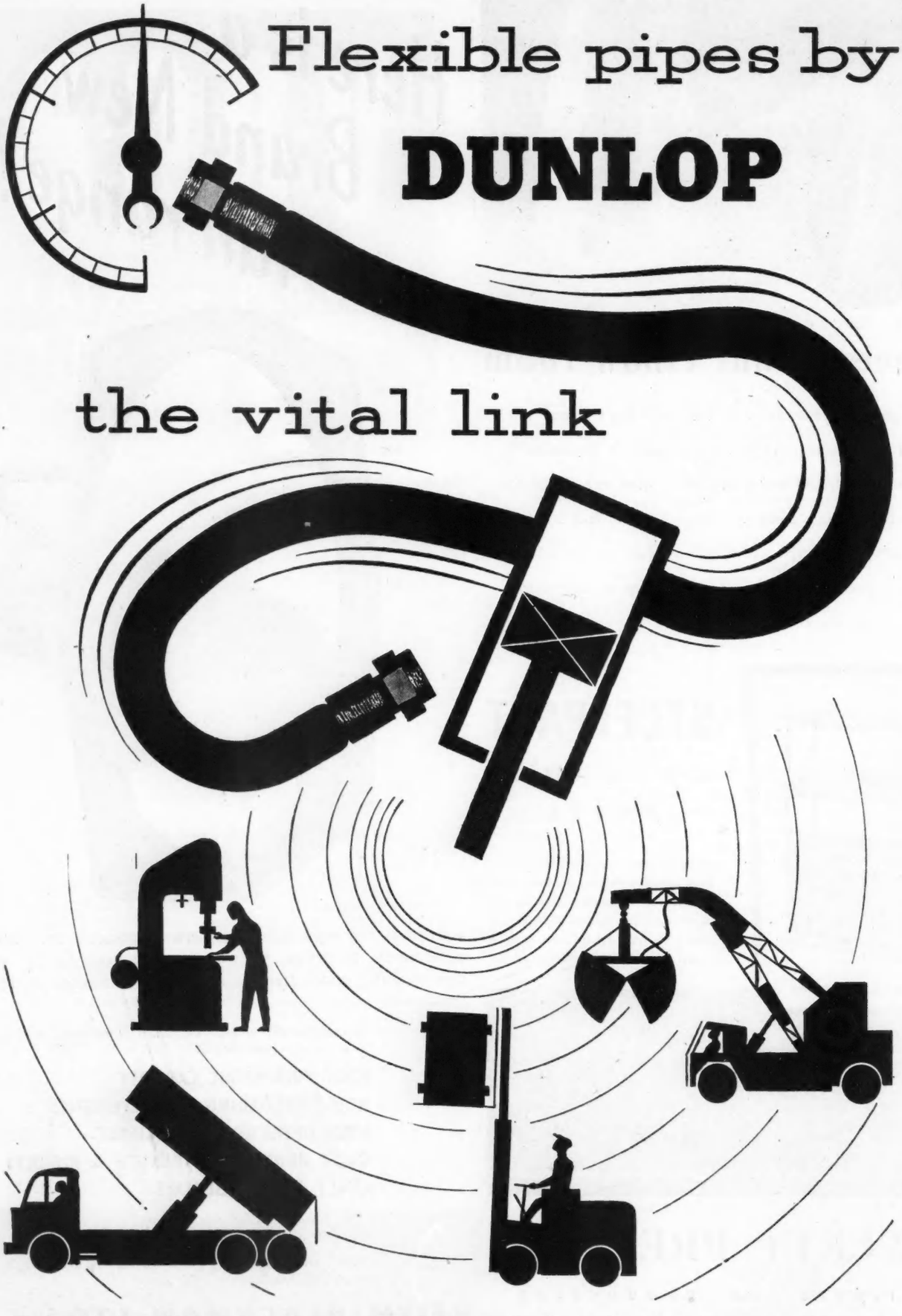
KEITH BLACKMAN LTD

Mill Mead Road · London N17

TA 7949/648

Flexible pipes by DUNLOP

the vital link



Dunlop technicians will always advise on any problems concerning installation of flexible piping. Write please to:—

DUNLOP RUBBER COMPANY LIMITED · ST. GEORGE'S ROAD · COVENTRY · TELEPHONE: COVENTRY 64171

SPECIAL PURPOSE MACHINES

FOR ALL INDUSTRIES

To their world-renowned range of MORRISFLEX Flexible Shaft and Polishing Shop equipment, B. O. Morris Limited of Coventry have now added :—

SEMI- AND/OR FULLY-AUTOMATIC POLISHING, BUFFING, BRUSHING AND FETTLING MACHINES . . .

designed specifically for individual operations to the special requirements of every branch of industry and in particular that engaged in the manufacture of Motor Car Accessories.

These Special Purpose Machines possess three very important advantages :—

1. **A CONTROLLED AND THEREFORE CONSTANT FINISH**
2. **A SKILLED RESULT FROM SEMI- OR UNSKILLED HANDS**
3. **A SOLUTION TO THE PROBLEM OF LABOUR SHORTAGE**

B. O. Morris Limited, will be pleased to place their unrivalled polishing and finishing technique together with their specialised engineering experience and resources at your disposal.

Morrisflex

B. O. MORRIS LTD., MORRISFLEX WORKS, BRITON ROAD, COVENTRY
Telephone : COVENTRY 5081 Telegrams : "MORISFLEX, COVENTRY".

DUSGARD now a proved success . . .

. . . for protection in the DANGER ZONE

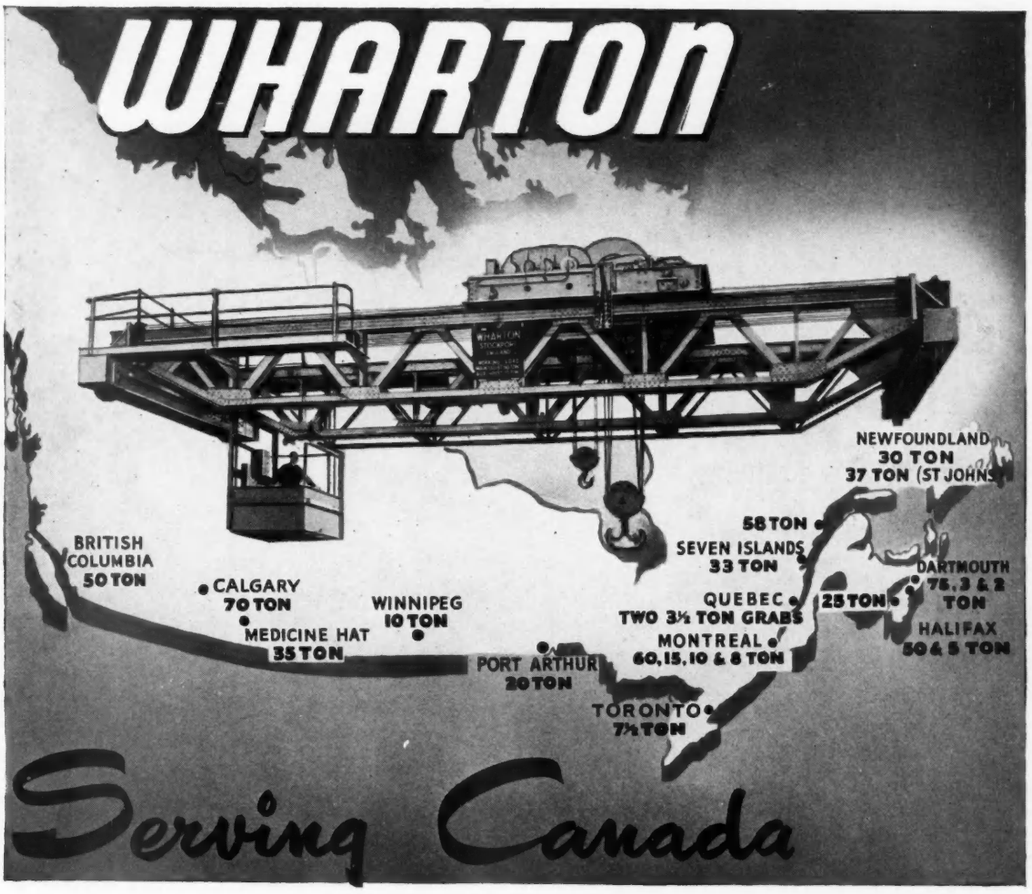
Yesterday—a novelty. Today—tested and proved. Dartmouth Auto Castings Ltd. handle more than 550 tons of Castings per week in the dressing shop shown above. Here DUSGARDS have been working efficiently for more than a year. Already twelve are in use, and others are in course of installation. Benefit from the experience of Dartmouth Auto Castings and other leading foundries, and fit the DUSGARD to your stand grinders.

The DUSGARD is manufactured exclusively by

Air Control Installations Ltd.

RUISLIP · MIDDLESEX · RUISLIP 4066 (8 LINES)

BIRMINGHAM	MANCHESTER	NEWCASTLE	GLASGOW
Midland 1166 and 1367	Central 0679 and 0670	Whitley Bay 23046	Central 2923



We are maintaining a steady flow of overhead crane deliveries to all parts of Canada.

The confidence of our customers is retained by our ability to make delivery on time.

Prices can be quoted for cranes landed on site and erected under the supervision of our own skilled staff.

Our agent in your province will visit you on request.

THE WHARTON CRANE & HOIST CO. LTD.

REDDISH STOCKPORT ENGLAND

Grams: "Gallant, Manchester." Code: Western Union

Representatives

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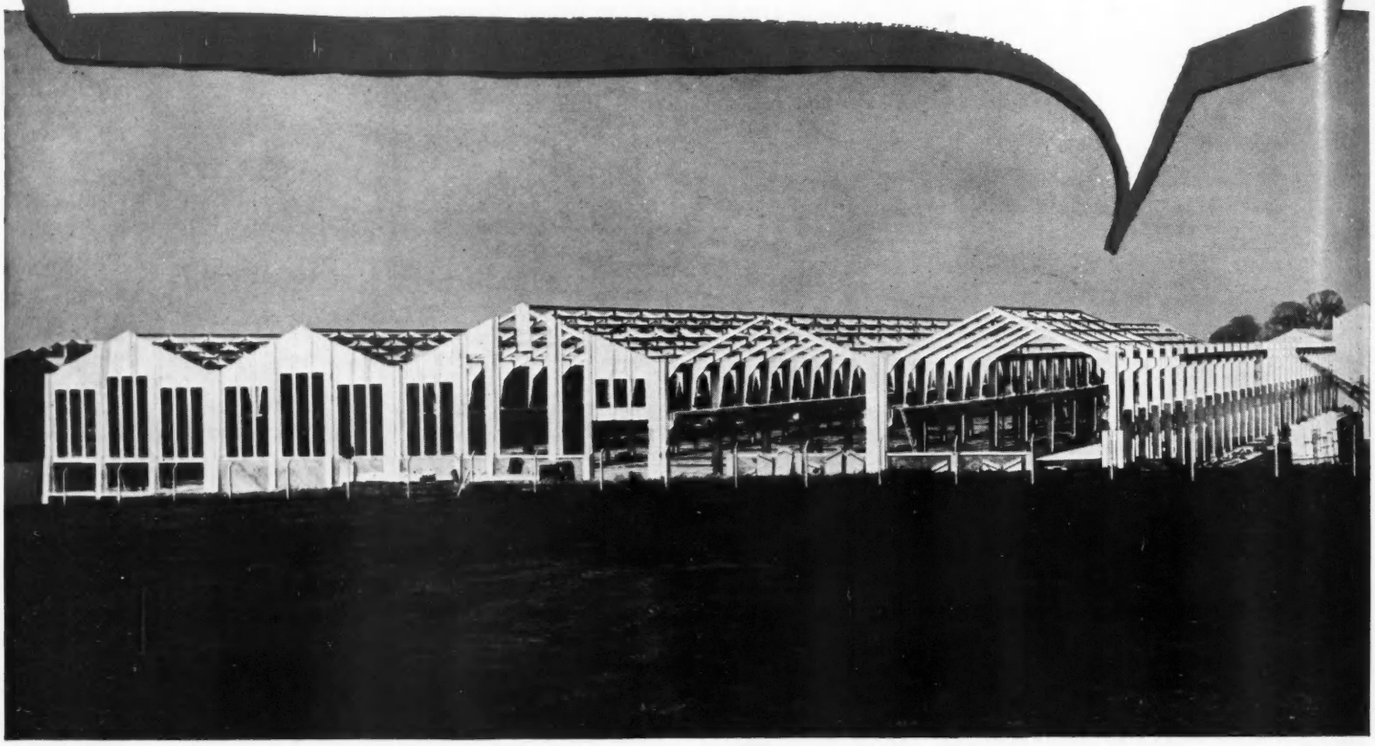
Marshall Equipment Company, Inc., P.O. Box 28, 61 Victoria Avenue, Dorval Station, Montreal, P.Q. *Phone: Melrose 1-3528 Grams: Marquipco, Montreal*

MANITOBA SASKATCHEWAN AND ALBERTA:
Mumford, Medland Ltd., 576 Wall Street, Winnipeg, Man. *Phone: 37-187; 37-188; 37-189; 37-180. Grams: "Mandem"*

BRITISH COLUMBIA:
Gordon Russell Ltd., 2205 Fir Street, Vancouver, 9, B.C. *Grams: "Rustle"*

A GUARANTEE has been given by Beecham Buildings Ltd. to complete a new factory of 200,000 sq. ft. and considerable intricate ancillary work for an Industrial organisation in the Midlands — within a year.

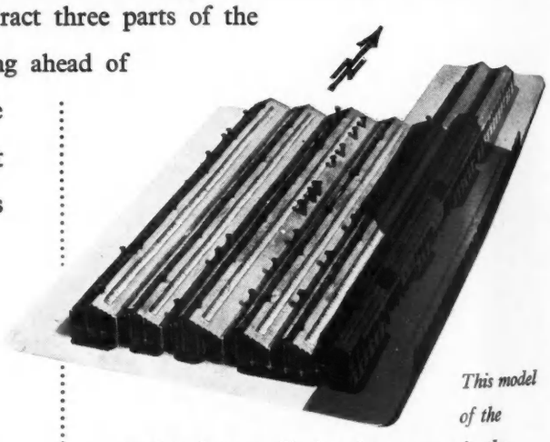
This is the sixth advertisement telling the story.



The goal is in sight!

Speed and efficiency, always inseparable from substantial progress, have brought this Beecham contract three parts of the way to successful completion. With 4½ spans erected, the job is racing ahead of schedule—thanks to scrupulous planning, the daily production of concrete components sometimes weighing 6 or 7 tons and the employment of advanced techniques that simplify fabrication. Future prospects of fine weather increase the possibility of finishing the project well within the guaranteed time.

Further advertisements will conclude the story of this contract—proving the worth of Beecham methods and a Beecham guarantee.



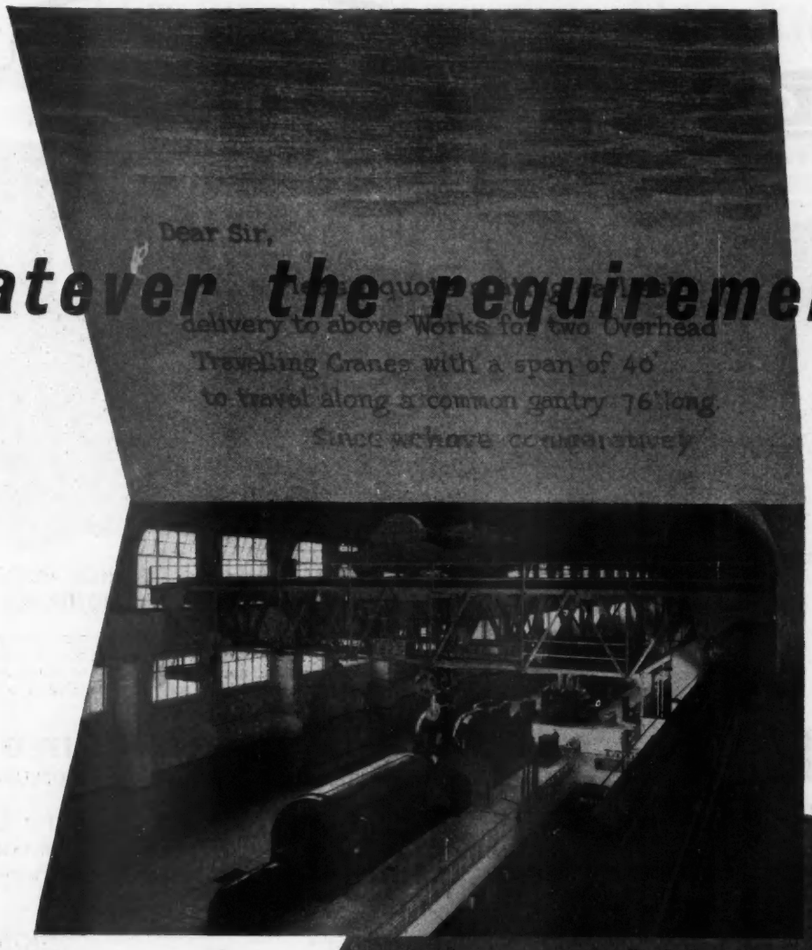
This model of the complete factory will pin-point progress in the advertisements which follow.
Progress to date includes 150,000 cubic yards of excavation; perimeter roads, North extension, foundations and floors complete and 4½ spans erected.

Beecham Buildings

May we advise you on the construction of permanent and competitive Industrial Buildings?

BEECHAM BUILDINGS LTD
DEPT. G
SHIPSTON-ON-STOUR, WARWICKSHIRE
Telephone: Shipston-on-Stour 315, 316 & 3287

AP.211.51



Heavy Steelworks Duty or

Light Factory Duty

40 feet span or

120 feet span

Whatever the requirements...

Intermittent Duty or

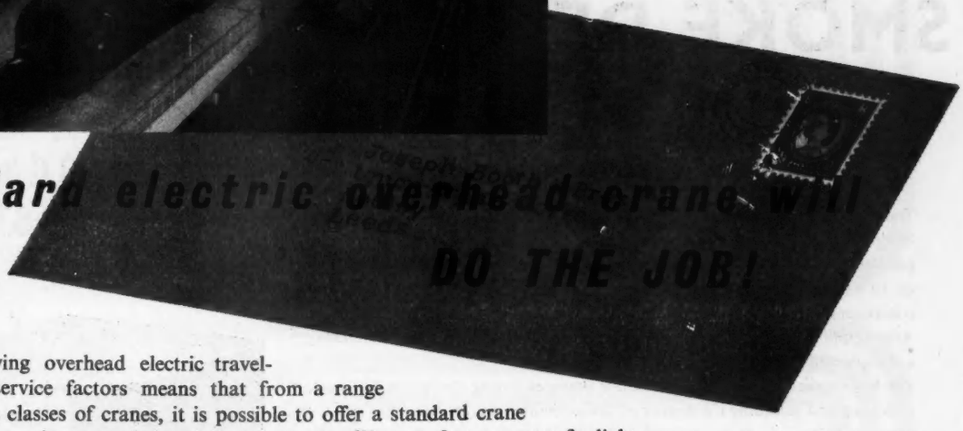
Continuous Duty

Lifting capacity 3 tons or

Lifting capacity 200 tons

1000 maximum hours per annum or

5000 maximum hours per annum



a BOOTH standard electric overhead crane will DO THE JOB!

THE Booth method of classifying overhead electric travelling cranes to suit varying service factors means that from a range of five classes of cranes, it is possible to offer a standard crane to serve almost any industrial requirement. We manufacture cranes for light duty up to continuous process cranes for Steelworks, and installations within this range have been carried out in many factories and Steelworks in this country and abroad. Grading of cranes effects considerable economies by making it possible to standardise components within each group whilst still retaining the advantages from the purchaser's point of view of being able to choose a crane to suit the duty required.

The Booth Handbook of Overhead Cranes is a comprehensive publication containing practical information which will be of interest to crane users. It fully explains the Booth method of classifying overhead cranes to suit varying service factors and gives detailed information and hints on fixing crane particulars which would be of assistance to any firm contemplating additional craneage.—

From a wide experience in designing and building all types of crane installations we should be pleased to submit proposals and designs to suit any requirements

BOOTH CRANES

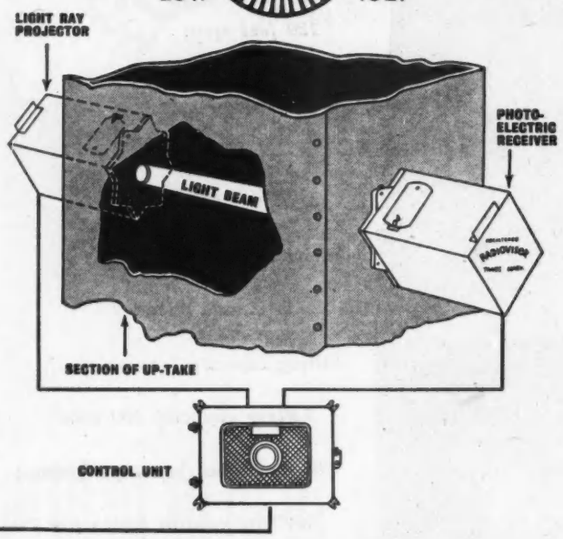
JOSEPH BOOTH & BROS · UNION CRANE WORKS · RODLEY · LEEDS Telephone: Pudsey 3168 Telegrams: "Cranes, Rodley."

Associated with *CLYDE CRANE & ENGINEERING CO., MOSSEND, SCOTLAND.* Proprietors: *CLYDE CRANE & BOOTH LTD.*

JB/2/17

RADIOVISOR

EST. 1927

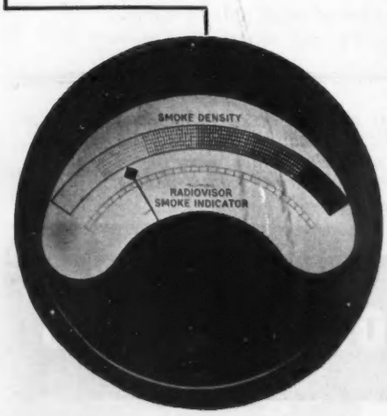


INDUSTRIAL SMOKE DENSITY INDICATOR

Used by Leading Industrial Companies for the past 25 years

The Radiovisor Industrial Smoke Density Indicator is in extensive use in Power Stations and Industrial installations to give a continuous record of the smoke passing through a flue or up-take. A beam of light is projected across the flue on to a Photo-Electric Cell. The intensity of light received by the latter, and consequently the photo-electric current, is governed by the smoke density. After amplification, the photo-electric current is indicated on instruments having a Ringelmann Smoke Scale.

The Radiovisor Smoke Density Indicator operates during the whole 24 hours, indicating and recording the density of smoke emitted and showing the operator when attention is needed. In addition, an accurate record is available to the Management to prove they are not contributing to air pollution. *There is a range of standard equipment to cover all sizes and types of installations.*



Other Radiovisor Photo-Electric and Electronic Controls include :—

FLAMESTAT FLAME FAILURE CONTROL
HOPPER AND BUNKER LEVEL CONTROL
SMOKE ALARM
PHOTO-ELECTRIC SAFETY GUARD
SMOKE DETECTOR FIRE ALARM
FACTORY LIGHTING CONTROL
TURBIDITY EQUIPMENT
AUTOMATIC RADIATION PYROSTAT
AUTOMATIC DOOR OPENING

RADIOVISOR PARENT LTD., 1, STANHOPE ST., LONDON, N.W.1

Telephone ✱ EUSton 5905

THE FIRST NAME IN PHOTO-ELECTRIC CONTROLS

Perfection IN DESIGN Precision IN MANUFACTURE

VARIABLE CAPACITY PUMPS

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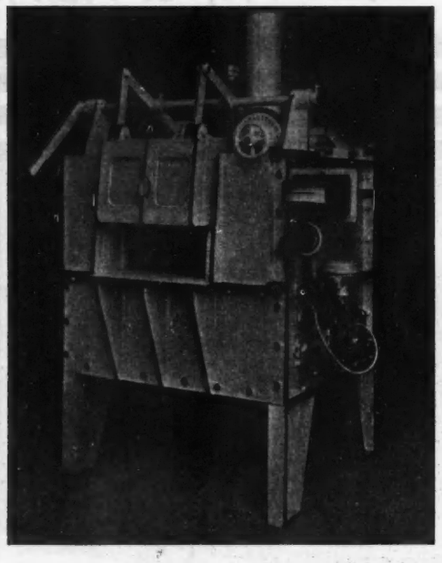

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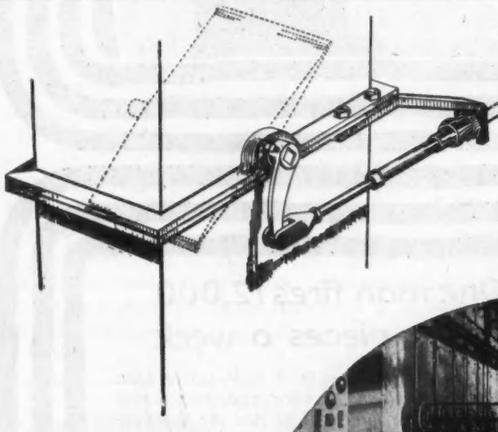

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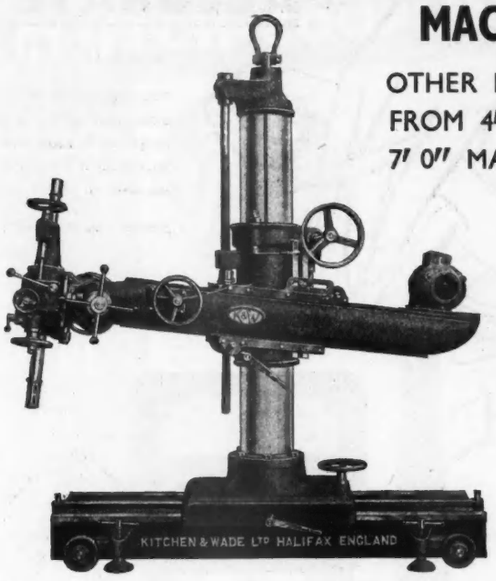

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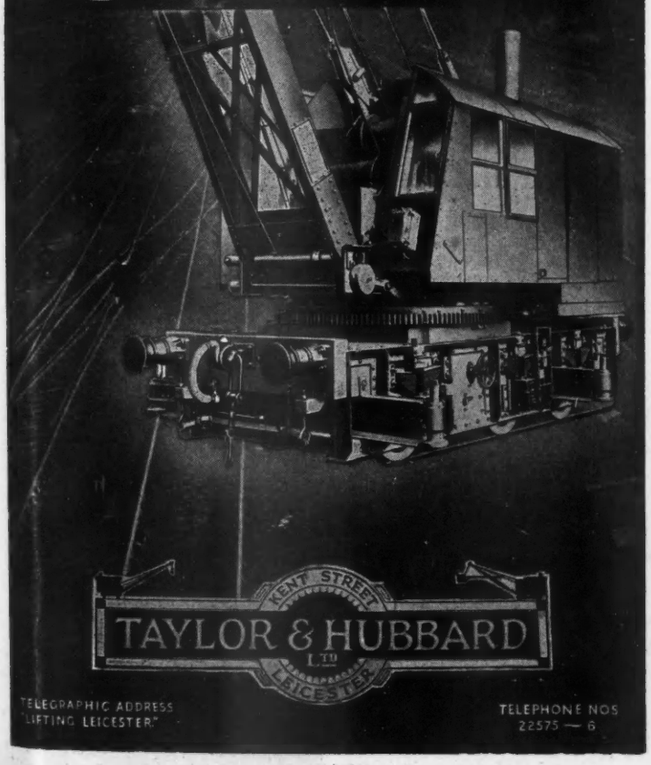

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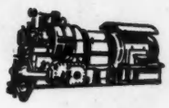

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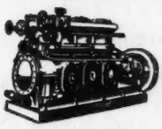

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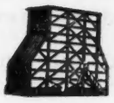

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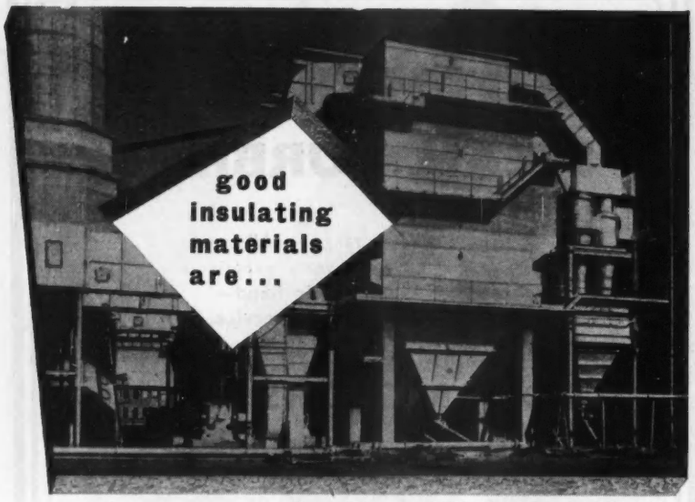

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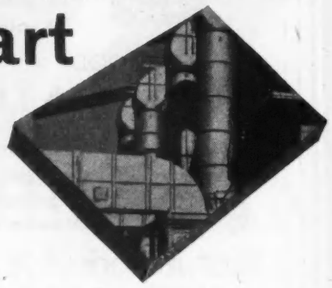

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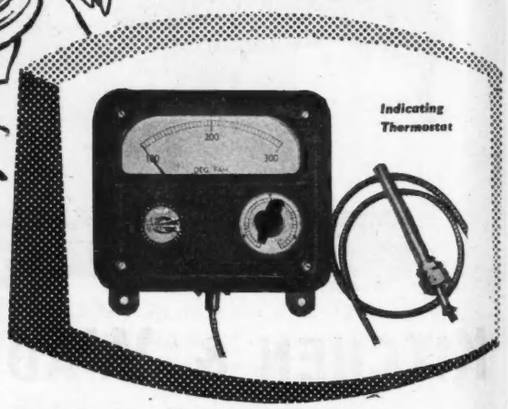

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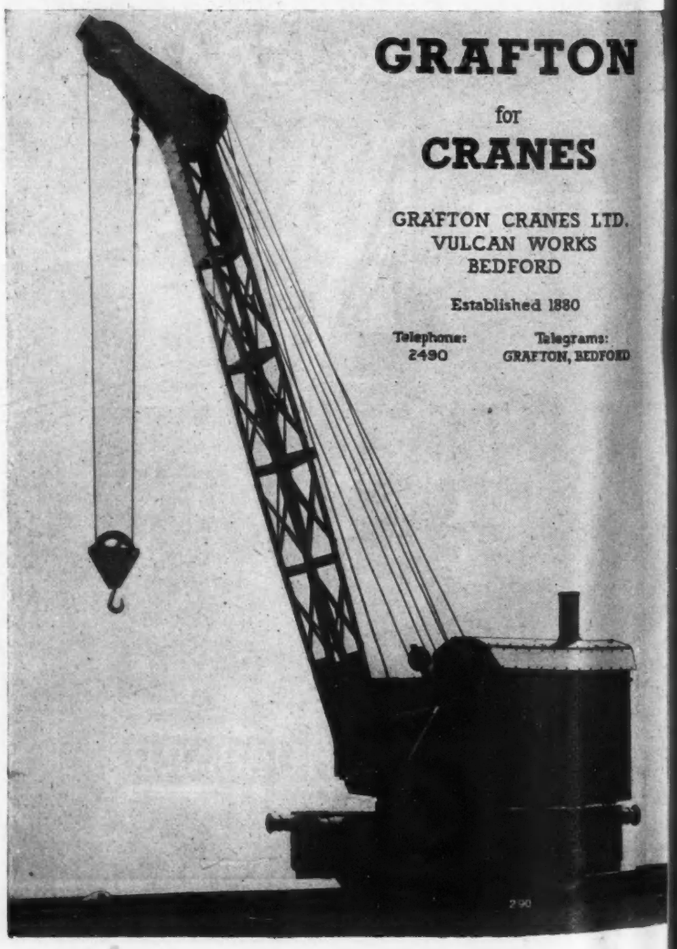

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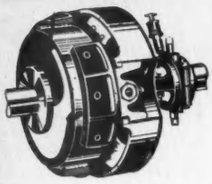

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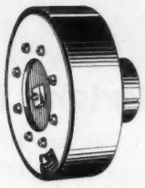

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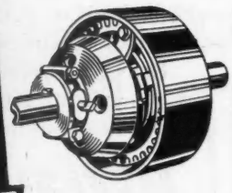

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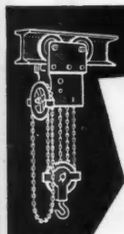

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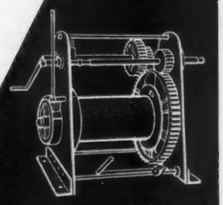

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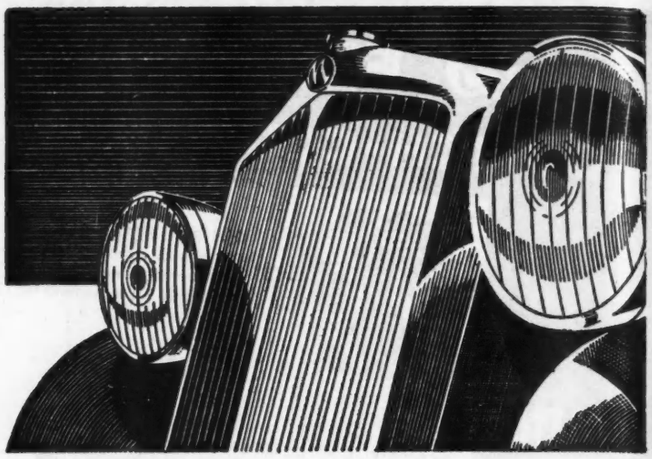

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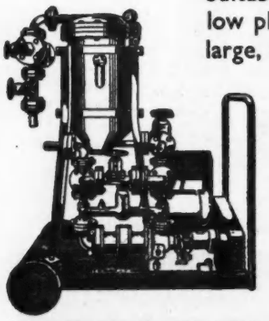

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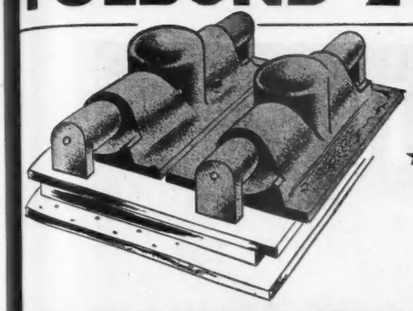

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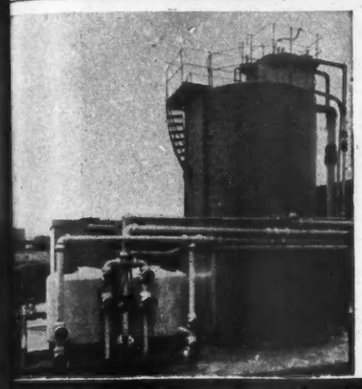

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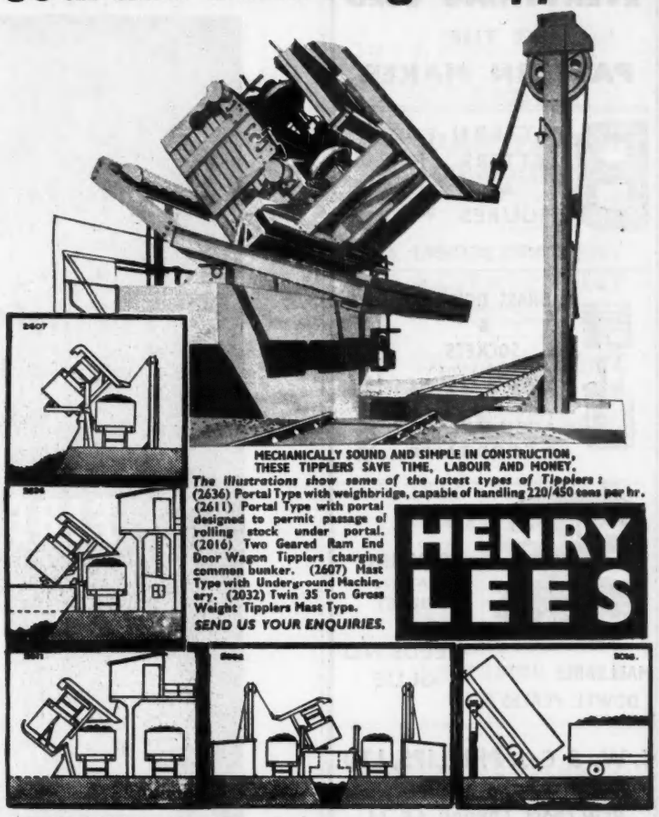

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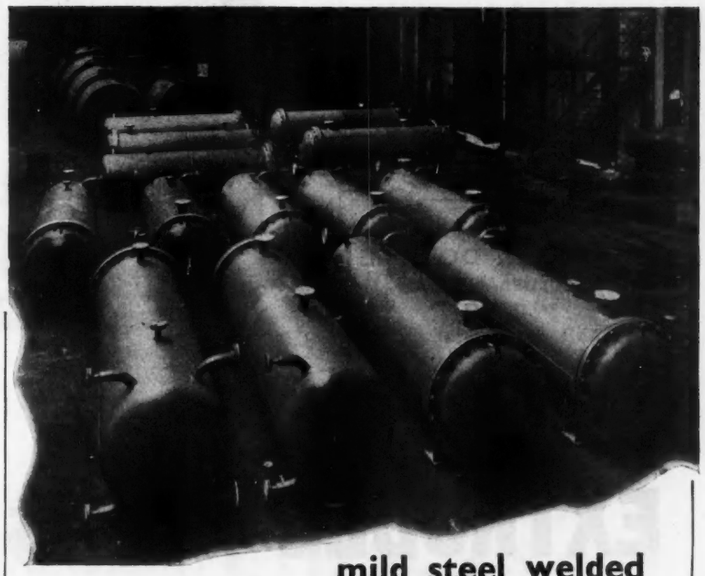

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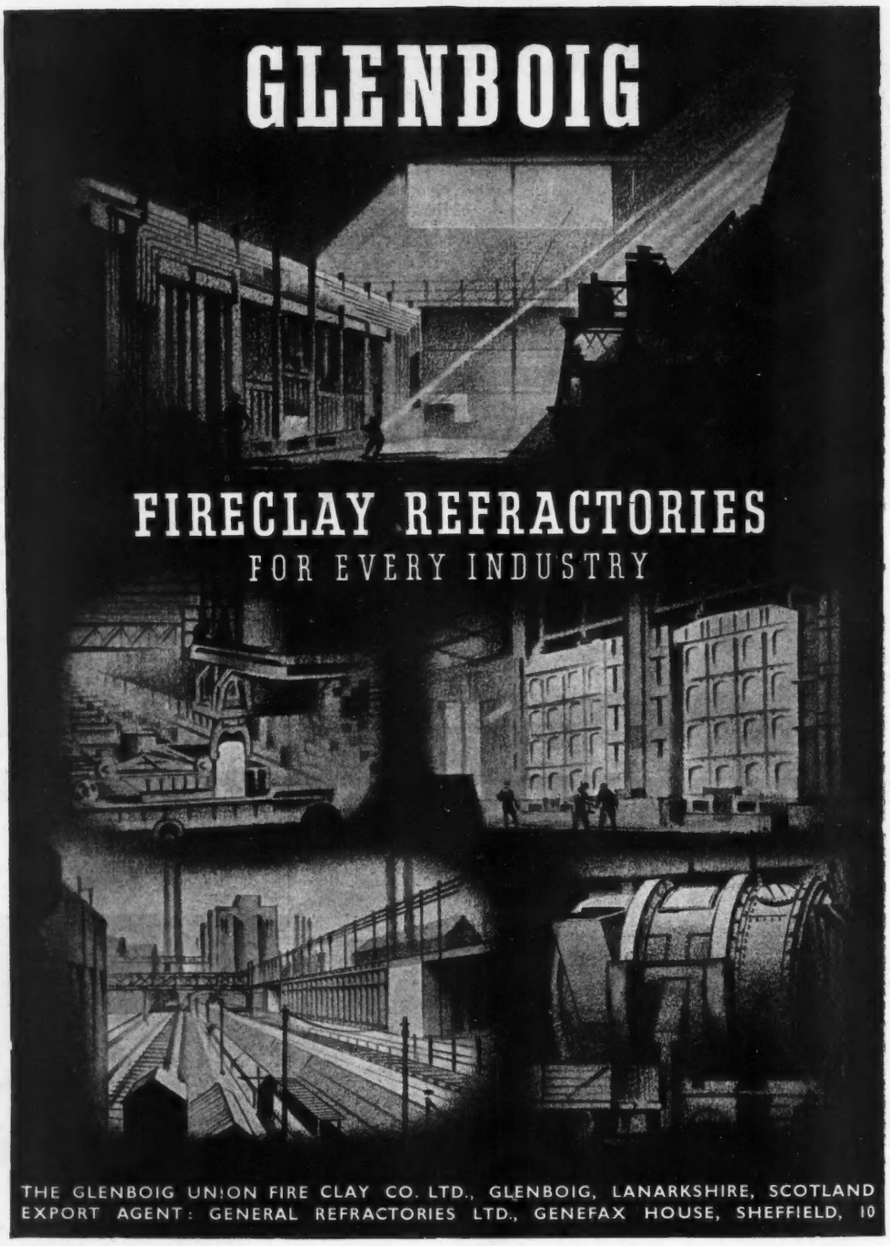

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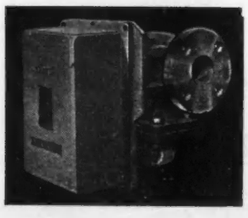

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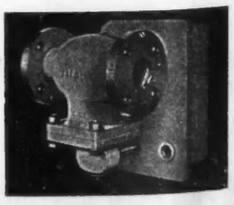

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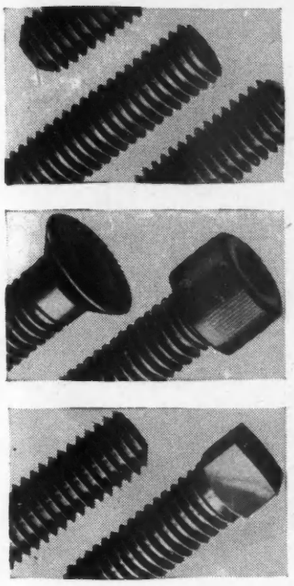

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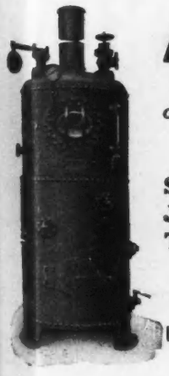

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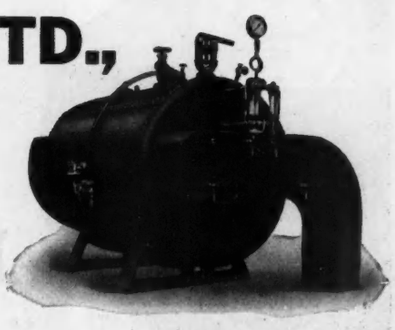

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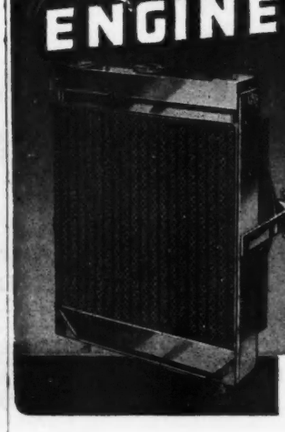

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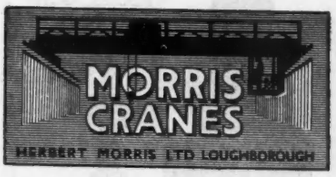

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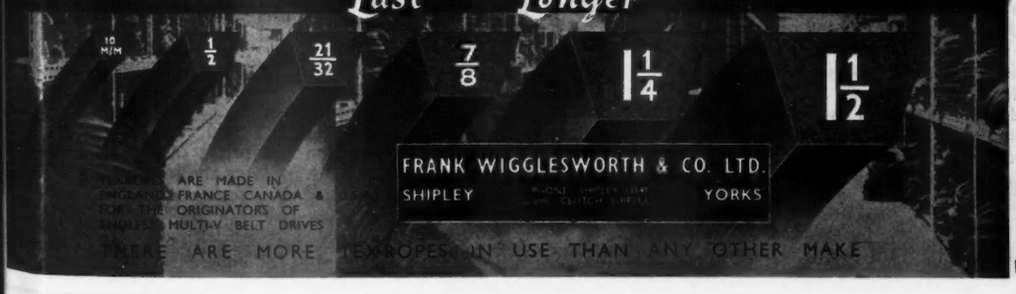
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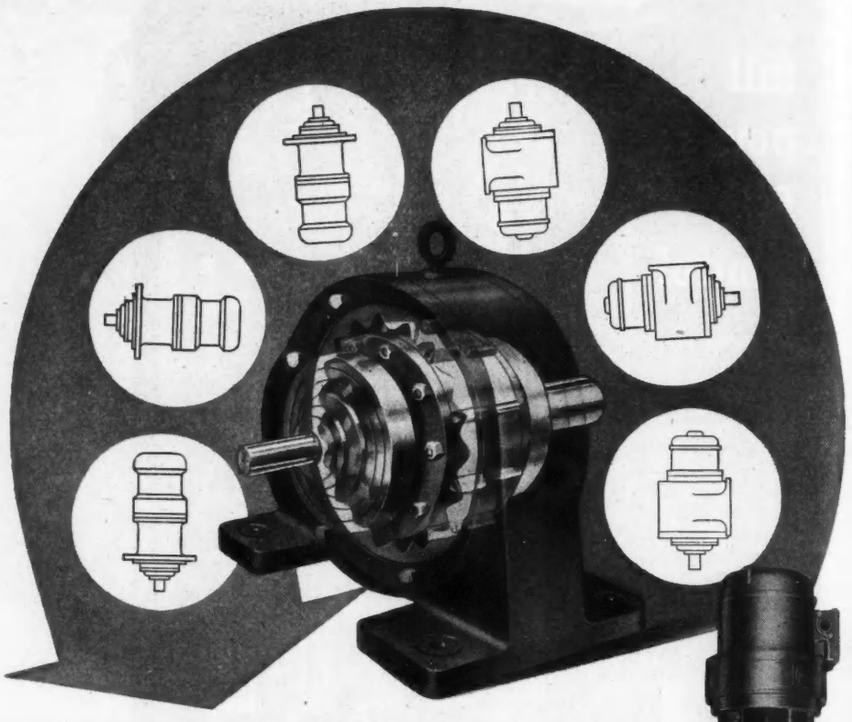

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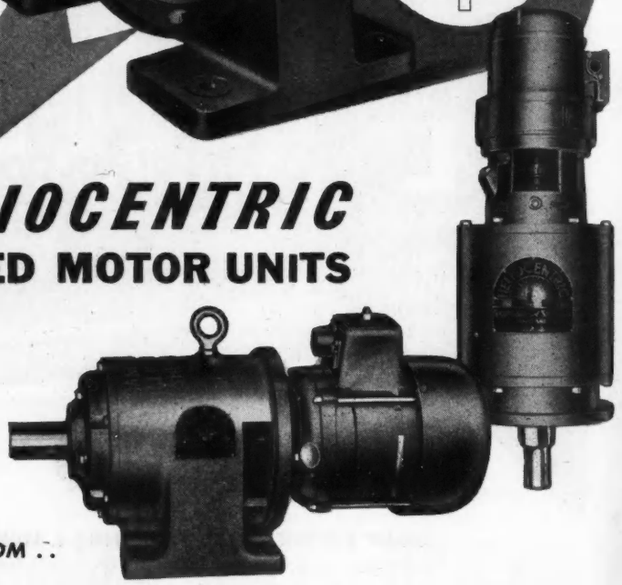

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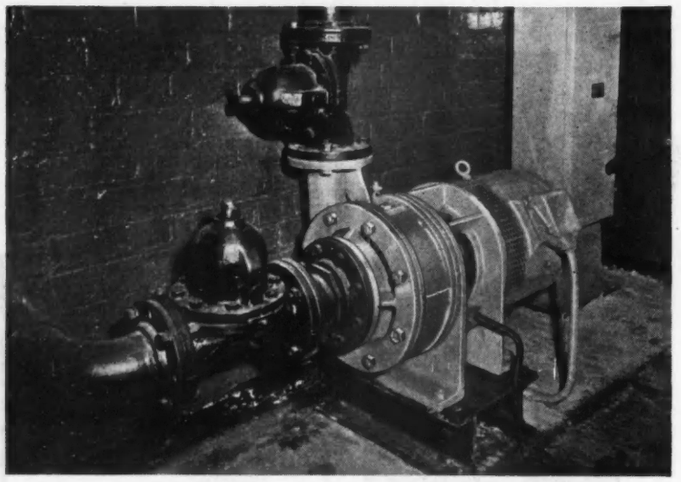

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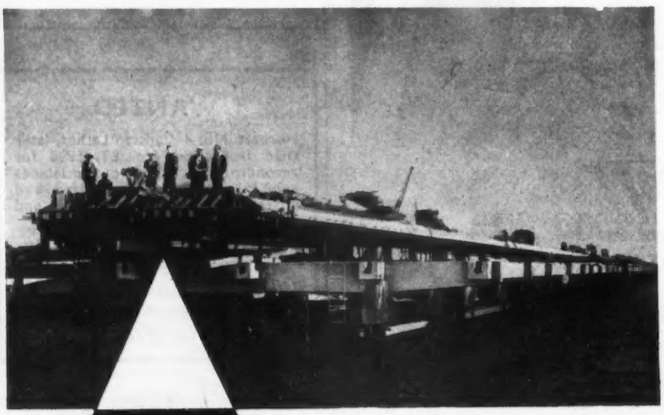

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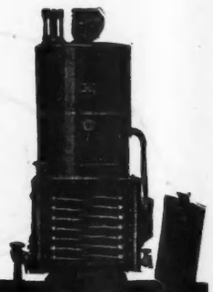

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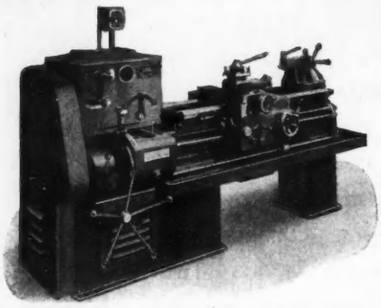

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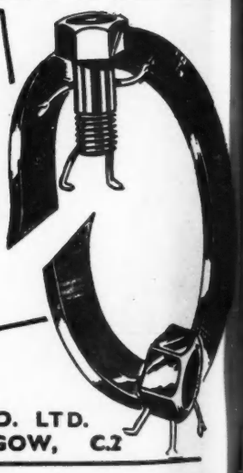

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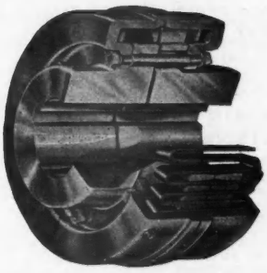

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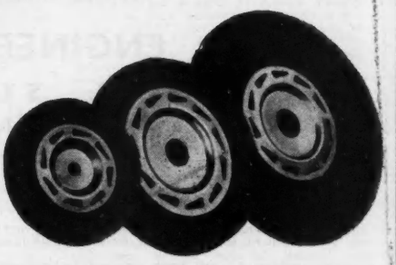

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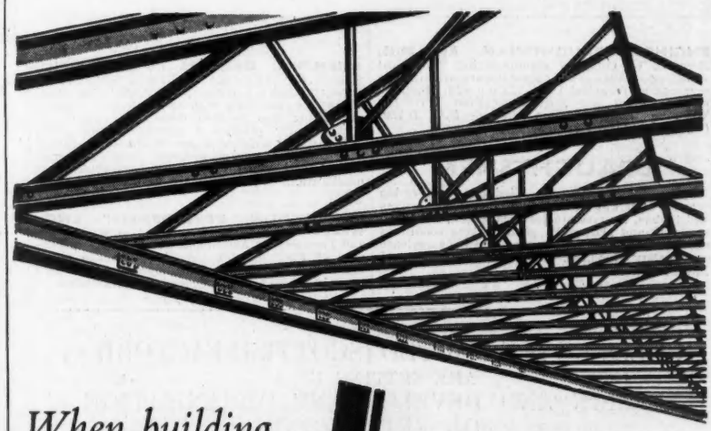

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have vacancies in their expanding laboratories for **YOUNG ENGINEERS WITH INTER.B.SC., H.N.C. OR DEGREE** and some experience in electronics for work on automatic pilots and other electronic devices. Good salary and prospects.—Apply: PERSONNEL OFFICER, LOUIS NEWMARK, LTD., PREFECT WORKS, PURLEY WAY, CROYDON, SURREY. D 757

CHIEF JIG AND TOOL DESIGNER, aged about 35, qualified A.M.I.Mech.E. or A.M.I.P.E., required by reputable London Company. Permanent appointment, commencing four-figure salary. Applicants must have had comprehensive practical Toolmaking experience and be thoroughlyconversant with Designing of Jigs, Tools and fixtures for light/medium precision engineering.—Apply, giving in confidence outline of qualifications and industrial history to BOX D 467, Offices of ENGINEERING.

THE BRITISH PETROLEUM COMPANY LIMITED, invites applications from **YOUNG GRADUATES** with a degree in Engineering, Physics, Mathematics or Natural Philosophy to be trained as Petroleum Engineers. Training will last for approximately 2 years and will take place partly in the United Kingdom and partly overseas. On successful completion of the training, men will be posted as Resident Petroleum Engineers to exploration areas overseas. Age preferably not over 26, National Service obligations must have been fulfilled.—Write stating age and full details of qualifications and experience, quoting H.2089, to BOX 7646, c/o 191, GRESHAM HOUSE, E.C.2. G 475

LOUIS NEWMARK LIMITED,

have a vacancy in their laboratories for a **PHYSICIST OR ELECTRO-MECHANICAL ENGINEER** for development work on aircraft and allied instruments. Applications are invited from persons with a degree or similar qualifications who have had some industrial experience, preferably on work with gyroscopes or accelerometers. Good salary and prospects.—Apply Personnel Manager, LOUIS NEWMARK LTD., PREFECT WORKS, PURLEY WAY, CROYDON, SURREY. D 758

IMPERIAL CHEMICAL INDUSTRIES LIMITED
WILTON WORKS

ENGINEERS

MECHANICAL, STRUCTURAL, ELECTRICAL, CIVIL.

PERMANENT STAFF APPOINTMENTS await young Graduate Engineers with good Honours Degrees. The Wilton Works Site of 2000 acres in course of development in addition to providing general and varied experience in modern Engineering has its own special problems in design and materials.

The organisation is expanding and has opportunities for technical training followed by further training towards higher management.

Situated in the North Riding of Yorkshire near the coast, Wilton offers first-class working conditions, five-day working week, Pension Fund, and full recreational facilities.

WRITE FOR APPLICATION FORM TO STAFF OFFICER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, WILTON WORKS, MIDDLESBROUGH, YORKSHIRE, QUOTING ADVERTISEMENT REFERENCE ICI/X/226/c. D 647

ENGINEER DRAUGHTSMAN. AGE 20/25. Required by Company manufacturing Mechanical Handling Plant. The appointment will include preparation Technical Data, Liaison with Manufacturers' Design and Engineering Staff. Five-day Week and Superannuation Scheme.—BOX D 520, Offices of ENGINEERING.

DRAUGHTSMEN

Required by well-known Clydeside engineering firm for land water-tube boiler department, seniors and juniors, for pressure parts, pipework, structural steelwork and platework; good working conditions and pension scheme. State age, details of experience and salary required.—BOX D 482, Offices of ENGINEERING.

Applications are invited for **SCIENTIFIC OFFICERS** for the BRITISH STEEL CASTINGS RESEARCH ASSOCIATION, BROOMGROVE LODGE, SHEFFIELD, 10. Posts vacant for candidates with mechanical or chemical engineering bias to their training. Acquaintance with foundry practice a recommendation. This Association is building a new experimental station. Prospects good for future progress. Salary according to qualifications and experience. Usual professional qualifications expected. D 504

PRODUCTION DEVELOPMENT ENGINEERS required for Developing New Methods and Processes for Automobile Components. Experience of Planning and Layout of Machine Shops essential. Send details of age, experience and salary required to BOX D 499, Offices of ENGINEERING.

ROLLS-ROYCE LIMITED (SCOTTISH FACTORIES)
ARE SETTING UP A
DESIGN AND DEVELOPMENT ORGANISATION FOR JET ENGINES

At their new factory in the town of East Kilbride which is approximately 8 miles from Glasgow. This is a new project which will provide unlimited opportunities in the future and there are immediate vacancies for the following positions :—

DEVELOPMENT & TECHNICAL SERVICE ENGINEERS

Engine development for improved performance and extension of service life. Applicants should be of degree or equivalent standard with National Service completed, and preferably some previous experience in this type of work.

DESIGN DRAUGHTSMEN

Applicants should have minimum technical qualifications of H.N.C. and have experience of engine or accessory design.

DETAIL DRAUGHTSMEN

Applicants preferably with H.N.C. and previous experience on aero engine or accessory work.

HOUSING ACCOMMODATION

will be supplied after a probationary period of three months, during which time

SUBSISTENCE ALLOWANCE

will be paid.

Applications marked TE/20, giving full particulars of previous experience, qualifications, and salary required, to the

PERSONNEL MANAGER, ROLLS-ROYCE LTD., HILLINGTON, GLASGOW, S.W.2.,

after which arrangements will be made to interview suitable applicants in their own area. D 643

A CAREER FOR SENIOR PIPING DESIGNERS

An established international Company of consulting and contracting engineers to the chemical and oil industries invites applications from

SENIOR PIPING DESIGNERS

who seek permanent posts.

Applicants should have H.N.C. (Mechanical) or recognised engineering experience, plus good knowledge of pipework arrangement in oil refineries, chemical or power plant.

These posts carry progressive salaries, pension rights and generous sickness benefits. Temporary vacancies also exist for

DRAUGHTSMEN AND DRAUGHTSWOMEN

for piping work.

Apply in writing detailing age, qualifications and experience, to the

PERSONNEL MANAGER,
DEPT. 29/H,
KELLOGG INTERNATIONAL CORPORATION,
7-8, CHANDOS STREET, LONDON, W.1. D 676

GRADUATES IN MECHANICAL AND CHEMICAL ENGINEERING required for progressive positions in the Research, Design and Production Divisions of THE POWER-GAS CORPORATION LIMITED. Training given to men without previous industrial experience.—Apply to STAFF PERSONNEL MANAGER, PARKFIELD WORKS, STOCKTON-ON-TEES. G 549

SEVERAL SENIOR AND JUNIOR ENGINEER/DRAUGHTSMEN

required

for boiler plant layout, heating, ventilating, process and all piped services, by progressive London consulting engineers. Happy and conveniently situated office. Summer and spring holidays. Five-day week. Superannuation and bonus schemes. Excellent prospects for qualified men of the right type.—Write in first instance giving full particulars of education, training, qualifications, experience, age and salary, etc., to BOX G 538, Offices of ENGINEERING.

STRUCTURAL ENGINEERING DESIGNER required. Must be able to design competitively all classes of structure to modern practice. Experience of welding design an advantage. Pension Scheme and Canteen facilities. State age, qualifications, experience and salary required.—Applications should be addressed to THE DIRECTORS, JOHN BOOTH & SONS (BOLTON), LTD., Hulton Steelworks, Bolton. G 508

SENIOR STRUCTURAL DESIGNER/DRAUGHTSMEN and capable Detailers required by ASHMORE, BENSON, PEASE & CO., STOCKTON-ON-TEES. Must be accustomed to design and detail steel framed buildings, bunkers, pipe bridges, etc., for industrial plants. Company's flat, pension scheme, technical library and sports facilities available.—Apply stating age, experience, etc., quoting reference "F" to STAFF PERSONNEL OFFICER. G 517

JUNIOR DRAUGHTSMEN, having completed National Service, required for work on large chemical plant installations, A.E.S.D. minimum rates or above. Five-day week and superannuation scheme.—Apply by letter, giving details of technical education, to the CHIEF DRAUGHTSMAN, LAPORTE CHEMICALS LIMITED, CLIFTON HOUSE, EUSTON ROAD, LONDON, N.W.1. G 541

ASSISTANT ENGINEER with sound technical knowledge of air filtration problems and previous commercial experience for well-known firm in London area. Permanent position with salary according to ability. Five-day week; pension scheme. Holiday this year.—Write BOX D 550, Offices of ENGINEERING.

ENGINEER WITH ELECTRICAL OR PHYSICIST DEGREE required for development work on testing equipment for telecommunication cables. Permanent and pensionable position at salary commensurate with experience and qualifications.—Please apply, giving full particulars to PERSONNEL OFFICER, SOUTHERN UNITED TELEPHONE CABLES, LTD., DAGENHAM DOCK, ESSEX. D 549

IMPERIAL CHEMICAL INDUSTRIES LIMITED
METALS DIVISION, BIRMINGHAM

has vacancies in its

RESEARCH DEPARTMENT

for

DESIGN DRAUGHTSMEN

to undertake work associated with

(1) The melting and fabrication of TITANIUM.

(2) The behaviour of non-ferrous metals during drawing, pressing, extrusion and similar processes.

(3) The provision of special-purpose equipment required by the Research Department.

A wide variety of interesting problems is encountered in the work, all of which is associated with research and development projects. Successful applicants will be expected to supervise the manufacture of plant which they design and to participate in experimental tests. Candidates should possess a Higher National Certificate in Mechanical Engineering or an equivalent qualification. Commencing salaries up to £890 p.a. will be paid dependent upon age, qualifications and experience.—Application forms may be obtained from STAFF MANAGER, I.C.I. METALS DIVISION, KYNOCH WORKS, WITTON, BIRMINGHAM, 6, quoting RES/3. D 712

DRAUGHTSMEN

BX PLASTICS LTD., BRANTHAM WORKS, NR. MANNINGTREE, ESSEX, have the following vacancies for

DRAUGHTSMEN: (1) At Brantham Works—Draughtsmen with broad mechanical engineering background and training. Good salaries to men of proved ability. (2) At the Research Station, Lawford Place, Nr. Manningtree—a Draughtsman Designer for work in connection with Plastics Processing plant. Experience in this field is desirable but not essential. Applicants, aged 28 to 35, should possess Ordinary or Higher National Certificate, and experience of small precision engineering. All applications for the above vacancies should be made to the Personnel Manager at Brantham Works, giving details of age, training and experience. D 496

Applications are invited for the post of **ESTIMATING/CONTRACTS ENGINEER** with centrifugal pump manufacturers in London. Age limits 20/30. Estimating experience not essential but engineering background desirable, preferably H.N.C. but O.N.C. or other suitable qualifications considered.—BOX D 666, Offices of ENGINEERING.

JIG AND TOOL DRAUGHTSMAN. Housing assistance offered to Jig and Tool Draughtsman required by progressive Engineering Company situated in pleasant country district one hour West of London. Applicants should hold at least H.N.C. Good working conditions and canteen facilities.—Please write giving details of age, married/single, past experience, qualifications, present salary to BOX D 719, Offices of ENGINEERING.

DIESEL DEVELOPMENT ENGINEERS

For new development work on fuel injection equipment. Applicants should have degree in engineering or H.N.C., together with suitable experience in the diesel engine or commercial vehicle field.

SALARY UP TO £925 P.A.

Applicants will also be considered from younger men for position of

ASSISTANT DIESEL DEVELOPMENT ENGINEERS

SALARY RANGE
£550-£775 P.A.

These vacancies are permanent and pensionable and applications should be sent to the Personnel Manager, (Ref. D.I).

C. A. V. LIMITED
WARPLE WAY, ACTON, W.3.
G 495

BRITISH PETROLEUM COMPANY LIMITED requires
ENGINEERS OR PHYSICISTS with 1st or 2nd Class Honours Degrees, for experimental work on internal combustion engines including gas turbine engines and motor vehicle engines of high performance. Previous practical experience is not essential, but applicants should have a keen interest in this type of work. Age preferably not above 33. Salaries within the range £600 to £1200 per annum, according to qualifications and experience.—Write giving full details, quoting H.3299, to BOX 7770, c/o 191, GRESHAM HOUSE, OLD BROAD STREET, E.C.2. D 698

Vacancy for
ENGINEER to run Cold Storage Plant and maintenance of Tractors and General Farm Machinery. Good house on farm.—Apply: THE GROVE FARMS (HARWELL), LTD., WOODLANDS, MILTON HILL, ABINGDON, BERKS. D 675

A well-known Organisation has vacancies for
TWO TECHNICAL ASSISTANTS in the Production and Technical Department. Applicants must hold a good University Degree in Mechanical Engineering and be aged 24-30, having acquired a sound technical background in the engineering industry. An attractive salary is offered and in addition there are very good prospects for further promotion.—Reply, stating full details of age, qualifications and experience, to BOX D 748, Offices of ENGINEERING.

An opportunity exists with the BRITISH OXYGEN COMPANY for a
YOUNG ENGINEER. Applicants should be aged 22-27 and hold a good degree in Mechanical Engineering. Applicants should preferably have 1-2 years' industrial experience. This post offers excellent prospects.—Reply, giving full details of qualifications and experience, to PERSONNEL MANAGER, THE BRITISH OXYGEN COMPANY LIMITED, BRIDGEWATER HOUSE, CLEVELAND ROW, St. JAMES'S, LONDON, S.W.1. D 749

THE BRITISH OXYGEN COMPANY, LIMITED require two
MECHANICAL DRAUGHTSMEN for work at their Head Offices in the West End of London. Applicants should have had some experience of plant layout work. The positions are permanent and offer very good prospects.—Reply, giving full details of age, experience and qualifications, to PERSONNEL MANAGER, THE BRITISH OXYGEN COMPANY, LIMITED, BRIDGEWATER HOUSE, CLEVELAND ROW, ST. JAMES'S, LONDON, S.W.1. D 750

An excellent opportunity exists with the BRITISH OXYGEN COMPANY, LIMITED, for a
UNIVERSITY GRADUATE in Engineering. Successful applicants will be required to undergo a period of approximately six months' training and will eventually be appointed to the Sales Organisation of the Company. No previous experience is necessary and applicants should be within the age group 22-26.—Please reply to PERSONNEL MANAGER, THE BRITISH OXYGEN COMPANY, LIMITED, BRIDGEWATER HOUSE, CLEVELAND ROW, ST. JAMES'S, LONDON, S.W.1. D 752

DRAUGHTSMEN for maintenance and development of Seamless Steel Tube Plant. Heavy engineering experience desirable. Permanent pensionable positions to suitable applicants.—Write stating full particulars and salary required to STEWARTS AND LLOYDS, LIMITED, BROMFORD TUBE WORKS, WHEELWRIGHT ROAD, ERDINGTON, BIRMINGHAM, 24. D 705

TECHNICAL ARTIST (ILLUSTRATOR), current experience laying out and executing first-class perspective Instruction Book drawings, mechanical subjects, from blueprints. Good salary and prospects. Central London.—BOX D 634, Offices of ENGINEERING.

TRACERS required by Consultants in Westminster for work on Civil, Mechanical and Electrical Engineering and Shipbuilding. Preference given to some experience in Electrical and Shipbuilding. Hours 9.30-5.30 and one Saturday morning in six. Two weeks paid holiday this year.—'PHONE: SLOANE 0431. D 707

SKILLED PRECISION BENCH FITTER for Special Purpose Machines and Tools. Also Skilled Universal Miller.—Write or 'Phone CREIGHTON & PARTNERS, LTD., MINERVA ROAD, N.W.10. EGL. 6862. D 711

BRUSH ELECTRICAL ENGINEERING CO., LTD., invites applications from
QUALIFIED ENGINEERS FOR THE POSITION OF CHIEF ENGINEER of the Steam Turbine Division of Loughborough. The duties include responsibility for research, development, design drawing and testing and an extensive programme of development exists in all these aspects. Considerable experience of steam turbine engineering in industry is essential, coupled with high standards of administrative ability and appropriate educational qualifications. The appointment is permanent and will carry remuneration, status and superannuation benefits commensurate with the responsibilities involved.—Please write with full details in confidence to the TECHNICAL DIRECTOR, LOUGHBOROUGH. D 694

Interesting work available in modern drawing office for
MECHANICAL ENGINEERING DRAUGHTSMEN and also **STRUCTURAL DESIGNER DRAUGHTSMEN** at Steelworks with large development programme.—Applicants to state age, technical qualifications, experience and salary required to LABOUR MANAGER, SAMUEL FOX & CO., LTD., STOCKSBRIDGE WORKS, NEAR SHEFFIELD. D 679

CHIEF INSPECTOR required for Medium/Heavy Engineering concern in the Preston area. Applicants must have served an engineering apprenticeship, and be capable of inspection and supervision of staff in departments concerned with machining and erecting to very close limits.—Please supply full details of age, experience and qualifications to BOX D 702, Offices of ENGINEERING.

DRAUGHTSMEN.

Owing to further rapid expansion LOUIS NEWMARK, LTD., have the following vacancies at :—

NEW ADDINGTON.
DESIGN AND DETAILING DRAUGHTSMEN for the design drawing office of their aircraft instrument division for work on small mechanical devices. Apply: VULCAN WAY, NEW ADDINGTON.

CROYDON.
DRAUGHTSMEN experience in design and detailing of jigs and tools. Experience of press tools an advantage. Apply: PREFECT WORKS, PURLEY WAY, CROYDON, SURREY. Pension scheme, excellent working conditions, etc. D 760

SENIOR ENGINEER REQUIRED for Estimating Department of leading Centrifugal Pump Manufacturers in Yorkshire. Good technical education required with sound engineering training including apprenticeship. Experience should preferably include knowledge of estimating and contract procedure. Good salary and prospects for suitable applicants. Five-day week. Canteen facilities, Staff Pension Scheme.—Write giving full details of experience, training, qualifications and salary required to BOX D 740, Offices of ENGINEERING

EXPERIENCED MECHANICAL ENGINEERING DRAUGHTSMAN required. Good salary and working conditions with excellent prospects. Five-day week. Canteen facilities. Staff Pension Scheme.—Write giving full details of experience, qualifications, age and salary required to BOX D 741, Offices of ENGINEERIHG.

Vacancies with particularly good prospects have occurred for
TWO QUALIFIED ENGINEERS aged 22-28 with a National Organisation. After a period of training in the Company's processes, appointments will be made to the Production Manager's staff. These vacancies occur in two of the main industrial areas of the country and as far as possible appointments will be made to those branches nearest the applicant's home.—Reply, stating full details of age, qualifications and experience, to BOX D 746, Offices of ENGINEERING.

TIME STUDY ENGINEERS

Applications are invited from suitably qualified men with experience of Machine Shop, Assembly Flow Line and Metal Finishing Production as applicable to light engineering.

Salary will be commensurate with experience and the responsibilities of the position. Profit Sharing and Indirect Workers' Bonuses. Canteen facilities. Pension Scheme, etc. Existing holiday arrangements open to negotiation.

Applications, quoting Reference MAI/PLI/14, should be addressed to :—

THE PERSONNEL MANAGER,
S. SMITH & SONS (ENGLAND) LTD.,
CRICKLEWOOD WORKS, N.W.2. D 751

TECHNICAL REPRESENTATIVE required by Engineering Firm in Yorkshire to assist in development and sales of specialised drying machinery for the paper and board trade. Must have sound practical and technical knowledge of the trade. Excellent prospects. Good salary. Superannuation scheme.—BOX D 704, Offices of ENGINEERING.

WORKS MANAGER required for medium-sized Machine Tool Manufacturers employing 100/120 people in Manchester area. State qualifications, experience and commencing salary expected.—BOX D 674, Offices of ENGINEERING.

DRAUGHTSMEN

BEXFORD LTD., BRANTHAM, NR. MANNINGTREE, ESSEX, require
FIRST-CLASS SENIOR AND JUNIOR MECHANICAL DESIGN AND DETAILING DRAUGHTSMEN, for interesting work over a wide field on the design and development of machinery for the manufacture of Photographic Film Base. Salaries of the order of £12 10s. 0d. per week or over to men with good training and experience. Permanent position. Contributory pension scheme. Please write, giving details of age, training and experience, to the PERSONNEL MANAGER, BEXFORD LTD., BRANTHAM. D 485

BRITISH PETROLEUM COMPANY, LIMITED, require two
PLANT INSPECTORS for employment initially in London Office but later in U.K. or possibly overseas refinery. Applicants, aged 25-35 years, must have served full apprenticeship preferably with firm manufacturing boiler or pressure vessels and have had several years practical experience in operation and maintenance of steam boilers or pressure vessels. First Class B.O.T. (Steam) Certificate or A.M.I.Mech.E. essential. Salary according to age, qualifications and experience. Non-contributory Pension Scheme. Luncheon Club facilities.—Write giving full details, quoting H.3407, to BOX 7787, c/o 191, GRESHAM HOUSE, E.C.2. D 756

An industrial organisation requires
TWO SCIENCE GRADUATES. Successful applicants will be trained in both Technical and Non-Technical Departments for six months, followed by a period of specialised training in a particular field. Future prospects in an interesting and expanding industry are extremely bright. Age range 20-27.—Please reply, stating full details of age and qualifications, to BOX D 744, Offices of ENGINEERING.

A progressive organisation has a vacancy for a
QUALIFIED ENGINEER. The successful applicant must have a good potential and be capable of undertaking responsibility within a reasonable time. The vacancy is an attractive one with good prospects and a good commencing salary.—Please give full details of experience, age and qualifications, to BOX D 745, Offices of ENGINEERING.

A large Industrial Organisation wishes to interview young
PAKISTANI MECHANICAL ENGINEERS on behalf of its Pakistani Associated Company. Candidates must possess a good degree in Mechanical Engineering and preferably should have some industrial experience.—Reply, stating full details of age, qualifications and experience, to BOX D 747, Offices of ENGINEERING.

DESIGNERS, DESIGNER-DRAUGHTSMEN, AND DRAUGHTSMEN are required by large firm of Consulting Engineers for work in London Office, and in some provincial centres of England and Wales. Candidates should have had experience in one or more of the following branches of engineering: Civil, Structural (steel and R.C.) Mechanical, Mechanical services, Electrical, permanent posts for right men. Pension Scheme. Salaries up to £20 per week and subsistence allowance where applicable. Please reply giving details of previous experience and stating whether any preference for London or Provincial.—BOX 401, Offices of ENGINEERING.

Applications are invited for the position of
TECHNICAL REPRESENTATIVE by an important firm of Heavy Engineers and Iron Founders. The Company is seeking a man of 30-40 with a good engineering background who could represent them in a wide range of products from their heavy foundries and steel fabrication shops. Experience of iron and steel works equipment, heavy duty rolling stock and/or pressure vessels desirable. The position is superannuated, carries a good salary and bonus and a car is provided. Applications should give fullest particulars including age, education, previous experience and present salary.—BOX D 670, Offices of ENGINEERING.

ELECTRICAL MAINTENANCE ENGINEER wanted by large industrial concern in British East Africa. Should have served a recognised apprenticeship, must be able to take responsibility for maintenance and installation of new equipment. Preference given to men in the age group 23/30 years. Four-year tour with four months paid leave. Free passages. Superannuation and medical benefits. Salary commensurate with experience and qualifications.—Write BOX JN/85, c/o 95, BISHOPSGATE, E.C.2. D 671

THE PARSONS AND MARINE ENGINEERING TURBINE RESEARCH AND DEVELOPMENT ASSOCIATION have a vacancy in the
APPLIED PHYSICS SECTION which deals with a wide variety of problems, mainly concerned with noise and vibration. Applicants should have a degree in Physics or Mathematics, but previous experience is not essential. Salaries compare favourably with the Scientific Civil Service and there are superannuation and other benefits.—Apply in writing to the RESEARCH DIRECTOR, PAMETRADA RESEARCH STATION, WALLSEND, NORTHUMBERLAND. D 681

EXPERIENCED SUB-AGENT required for heavy foundation construction contract in North East Coast area.—Apply with particulars of experience to DORMAN LONG (BRIDGE & ENGINEERING), LTD., BRIDGE & CONTRACTING DEPARTMENT, 38-40, BUTE STREET, LUTON, BEDS. D 737

ADREMA LTD., LONDON (ACTON), have a vacancy for the post of
HEAD OF RESEARCH AND DEVELOPMENT at an initial salary of not less than £2000 per annum. Applicants should be qualified mechanical engineers with a good understanding of the application of electronics, and must have previous experience in the principles and design of office machines such as addressing machines, typewriters, punch card or accounting machines, printing and duplicating or similar equipment.—Applications with curriculum to the MANAGING DIRECTOR, ADREMA LTD., 2-10, TELFORD WAY, LONDON, W.3. D 686

WANTED for heavy foundation construction contract in North East Coast area,
JUNIOR SITE ENGINEERS.—Apply with particulars of experience to DORMAN LONG (BRIDGE & ENGINEERING), LTD., BRIDGE & CONTRACTING DEPARTMENT, 38-40, BUTE STREET, LUTON, BEDS. D 736

BRITISH PETROLEUM COMPANY, LIMITED, require
PLANNING ENGINEER for work in their London Office. Work involves planning and co-ordination of design, supply and construction and the preparation and progress of detail programmes and schedules. Applicants must have at least Higher National Certificate and have served Engineering Apprenticeship with subsequent experience in the planning, design or construction of medium or heavy chemical or oil plants. Age 30-40. Non-contributory Pension Scheme, luncheon club. Salary according to age, qualifications and experience.—Write, giving full details including age, quoting H.3396, to BOX 7780, c/o 191, GRESHAM HOUSE, OLD BROAD STREET, E.C.2. D 738

CRANES

DRAUGHTSMAN, EXPERIENCED IN CRANE WORK, required by large Firm in Yorkshire. Permanent position offered with good prospects of advancement. House available for suitable applicant. Pension scheme in operation and excellent working conditions. Liberal salary offered commensurate with experience and ability.—Full details to be given in application which will be treated in confidence, to the Secretary.—BOX D 562, Offices of ENGINEERING.

GRADUATE CIVIL ENGINEER

COURTAULDS LIMITED requires a

RECENT UNIVERSITY GRADUATE IN CIVIL ENGINEERING for site supervision and the design of works involving Civil Engineering, Structural Engineering and General Building. Initial employment would be in North Lincolnshire where a new factory is under construction. This would provide experience in piled foundations, reinforced concrete and structural steel construction as a preliminary to subsequent and pensionable employment mainly at the Company's Coventry Headquarters.

Candidates should write for a detailed form of application to the DIRECTOR OF PERSONNEL, COURTAULDS LIMITED, 16, ST. MARTIN'S-LE-GRAND, LONDON, E.C.1, quoting the reference number B.27. D 365

Classified Advertisements continued on Page **100**

TEST ENGINEER

Applications are invited from young engineers with the theoretical knowledge and practical ability to enable them to undertake responsibility as Test Engineers engaged on the testing and commissioning of large-scale chemical plant.

Two appointments are offered, and each will give excellent opportunities, both for good experience in the test engineering and design liaison fields, and of an excellent career.

The post will entail considerable travelling within the British Isles, although the appointment will be based in London.

Applications giving full details of age, experience, qualifications and present salary to Box D 636, Offices of ENGINEERING.

DRAUGHTSMAN, ELECTRICAL, required for work on varied works distribution layout designs in connection with Cement, Brick and Tile manufacturing plants.

Complete installations from substation to motors up to 800 h.p. including controls, cabling and distribution; knowledge of ordering an advantage.

The post is permanent and a pension scheme is in operation.

Applicants should be of at least National or Higher National standards, and have had sound practical and drawing office experience.

Starting salary up to £800 per annum according to ability.

Write stating experience and qualifications to: THE CHIEF ENGINEER, EASTWOODS, LTD., 158/160, CITY ROAD, LONDON, E.C.1. D 709

DRAUGHTSMAN required in the Engineering Department of a well-known Cement, Brick and Tile Manufacturing Company.

Knowledge of industrial plant layout essential; experience in the design and layout of Cement and Brickmaking plant; mechanical handling equipment and structural steelwork an advantage.

The post is permanent and a pension scheme is in operation.

Applicants should be of at least National or Higher National standards and have had sound workshop and drawing office experience.

Starting salary up to £800 per annum according to ability.

Write stating experience and qualifications to: THE CHIEF ENGINEER, EASTWOODS, LTD., 158/160, CITY ROAD, LONDON, E.C.1. D 710

DESIGN DRAUGHTSMAN.

Progressive Engineering Company in Scotland now expanding its activities, has vacancy for Design Draughtsman with experience in the design of Centrifugal Pumps. Applicant should be capable of producing new designs of pumps for Land and Marine work. The working conditions are good. The position would be permanent and superannuated and offers scope for advancement to suitable man.—Please reply stating age, qualifications and experience, to BOX D 682, Offices of ENGINEERING.

REINFORCED PLASTICS.

LABORATORY ASSISTANTS required for interesting work for development of plastic structures for Guided Weapons. Academic qualifications, though desirable are not essential but some practical experience of work with glasscloth and low pressure resins is necessary.—Applications should be made to the EMPLOYMENT MANAGER, VICKERS-ARMSTRONGS LIMITED, WEYBRIDGE WORKS, WEYBRIDGE, SURREY. D615

ENGINEERS AND PHYSICISTS. The following vacancies exist in the Tyre Development Department of THE AVON INDIA RUBBER CO., LTD., MELKSHAM, WILTSHIRE :—

(1) **AN ENGINEER OR PHYSICIST** for work on Product Performance.

(2) **AN ENGINEER** for Production Control and liaison.

(3) **A PHYSICIST** for basic research into tyre design and performance.

These appointments cover a wide and interesting variety of work in an expanding Company and offer considerable scope for men with initiative. An Engineering or Physics Degree is a minimum qualification, with vacancy No. 3 requiring an honours standard. Previous experience in the rubber industry is not essential and graduates without industrial experience will be considered.—For further particulars apply to THE SECRETARY, giving personal details and previous experience. D 626

DESIGN AND DEVELOPMENT ENGINEER required with experience in Design and Application of Rotary Vacuum Pumps and Low Pressure Air Compressors. Good prospects for suitable applicant who must be capable of working on own initiative, reliable and competent.—BOX D 630, Offices of ENGINEERING.

ENGINEER, AGED 30-40, with experience in the layout of complete conventional Power Stations is required in the Atomic Energy Department of The General Electric Co., Ltd., at Fraser and Chalmers Engineering Works, Erith, Kent. A University Degree and several years in a senior capacity in an Organisation dealing with the above type of work is essential.—Apply PERSONNEL MANAGER, FRASER & CHALMERS ENGINEERING WORKS, ERITH, KENT. D 655

Applications are invited from
DRAUGHTSMEN-DESIGNERS experienced in electro-mechanical equipment, mainly for aircraft. Excellent working conditions in pleasant surroundings in South Wales, 24 miles from Cardiff and coast; alternatively, in Nottingham or Reading.—Apply giving full particulars, to CHIEF ENGINEER, TEDDINGTON AIRCRAFT CONTROLS, LTD., CEFN COED, BRECONSHIRE. D 689

ENGINEERS, DESIGNERS AND DRAUGHTSMEN required for Mechanical Engineering Department of SIR ALFRED McALPINE AND SON, LTD., Hooton, Wirral, Cheshire D 680

BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH, LEICS., have vacancies for
RESEARCH ENGINEERS to assist with advanced projects connected with the development of electrical machines. Men interested in Servo-mechanisms, Ventilation, Insulation, Mechanical Design or associated technologies are invited to apply. Candidates should possess a good degree in electrical or mechanical engineering, have previous experience of research or development and be prepared for further study. Conditions of service include non-contributory staff assurance scheme.—Please apply with full details to CHIEF PERSONNEL OFFICER, BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH, LEICS. D 645

TECHNICAL SALES ENGINEER required by small but progressive Manufacturing Engineers. Applicant must be conversant with Vacuum Applications to Industrial Laboratory Equipment and Low Pressure Air Applications. Good prospects for suitable applicant.—BOX D 631, Offices of ENGINEERING.

METHOD STUDY ENGINEER required for Engineering Department of large progressive batch-type production factory. Applicants should be 27 to 35 years of age, with engineering training and technical education to H.N.C. standard and preferably trained in motion study practice. The job, which is of wide scope and varied nature, involves working as a member of a team engaged upon problems concerning the expansion and improvement of factory production plant. The post is a permanent senior staff appointment, and a contributory pension scheme is in operation.—Applications stating age, training, experience, salary required, etc., and quoting reference E/MSE4, to PERSONNEL MANAGER, FERODO LIMITED, CHAPEL-EN-LE-FRITH, VIA STOCKPORT. D 625

WORKS MANAGER required by well-known Wolverhampton company to control modern machine and assembly shops producing light non-ferrous components. Strength of character, administrative ability and general engineering background essential, including machine shop experience of bar, semi-automatics and capstans. Age 32-38. Salary and bonus about £1200 depending on experience and capability.—Write giving full details to BOX D 687, Offices of ENGINEERING.

ENGINEER for well-known firm in the London area, with sound technical knowledge of all problems relating to natural, induced, forced draught water cooling towers and other forms of heat exchangers. Previous commercial experience also necessary. Only qualified engineers in this field can be considered. Good salary to right man; five-day week; pension scheme.—Write BOX D 708, Offices of ENGINEERING.

CHIEF INSPECTOR

Applications are invited for appointment as Chief Inspector of a Division of a large Engineering Company.

Applicants should have considerable knowledge of machine shop operation on large and small batches and a wide range of machine types.

The appointment will entail responsibility for the direction and control of an inspection staff of some 60 skilled inspectors and viewers, and the successful applicant should be capable of introducing standard quality control methods where necessary.

Applications giving full information of experience, qualifications and salary required to Box D 637, Offices of ENGINEERING.

THE BRISTOL AEROPLANE COMPANY LIMITED

APPRENTICES' SCHOOL

Applications are invited for

ONE OR MORE FULL-TIME TEACHING POSTS AS ASSISTANT LECTURER GRADE 'A' (BURNHAM SCALE)

to teach workshop technology, mathematics and science subjects for City and Guilds workshop courses.

Good practical experience essential, and Higher National or Final City and Guilds Certificate, or equivalent in an engineering subject.

Appointments to date from 1st September, 1955.

Forms of application obtainable from CHIEF PERSONNEL OFFICER, FILTON HOUSE, BRISTOL. D 688

ASSISTANT SUPERVISOR for a West Country Factory steam and power raising plant. The plant concerned is raising 100,000 lb./hr. of steam on water tube boilers and generating 3000 kW on pass-out sets.

Applicants must be sound and practical and be able to demonstrate ability to run the plant, to supervise and to take complete charge as and when necessary. Applicants should also have a sound basic general education with appropriate technical qualifications.

Preference will be given to candidates holding a similar position today.—Write to BOX D 652, Offices of ENGINEERING, stating full particulars and salary required.

ENGINEER required to take charge of Design under guidance of Managing Director. Candidates should have served a Mechanical Engineering Apprenticeship and possess a degree in engineering or the equivalent. They should be within the age range 30 to 45, have had experience in medium-weight mechanical engineering, preferably with light locomotives and/or earth-moving equipment, and have a marked flair for heavy vehicle design evidenced by successful achievement in that field.—Applications, giving date of birth and full details of education, qualifications and experience, should be addressed to THE SECRETARY, MOTOR RAIL, LTD., SIMPLEX WORKS, ELSTOW ROAD, BEDFORD. D 639

ENGINEERING MANAGER. Post to be filled in London office of manufacturing and consulting firm. Work connected with gas turbines and atomic energy. Following desirable but all not essential : B.Sc. or A.I.Mech.E.; experience in control of draughtsmen; ambition; apprenticeship. Preferred age 30/40. Starting salary £1000-£15000 depending on experience.—BOX D 661, Offices of ENGINEERING.

CONSULTING ENGINEERS require in their Newcastle-upon-Tyne Office, Civil Engineers, Designer/Draughtsmen, Detailers, Senior and Junior, for interesting work in connection with the design of Steam Generating Stations and Development work in connection with Nuclear Energy Generating Stations covering a wide range of foundations, reinforced concrete and general Civil Engineering work. Five-day week; pension scheme; good working conditions. Applications treated in confidence.—State full details of qualifications and experience to MERZ & McLELLAN, CARLIOL HOUSE, NEWCASTLE-UPON-TYNE, 1. D 699

A TRAINING ASSISTANT is required by a large Iron and Steel Company to augment, in a junior capacity, the staff of the Training Officer at Newport (Mon.). His duties will be partly administrative, partly instructional and will cover the industrial training and education of adults and juniors. Some knowledge of and preferably practical experience in engineering and/or metallurgy are required. An additional desirable qualification is experience in teaching and/or youth work. It is regretted that the Company is not in a position to help regarding housing accommodation.—Application form, to be returned within two weeks of the appearance of this advertisement, will be forwarded on request to BOX D 695, Offices of ENGINEERING.

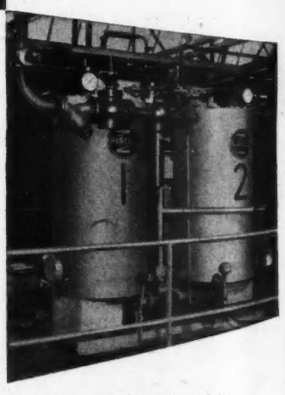
SEVERAL GRADUATE ENGINEERS are required for interesting technical, design and development work on Internal Combustion Engines. Applicants must hold a Degree in Mechanical Engineering and have practical experience. Excellent prospects are offered with a commencing salary of £750 to £1000 depending upon experience.—Apply in writing to THE CHIEF ENGINEER OF DESIGN, CROSSLEY BROTHERS, LTD., OPENSHAW, MANCHESTER, 11. D 696

DRY

AIR speeds and improves the drying out of refrigerator compressors

Sealed containers of all kinds require moisture exclusion. At the Nash-Kelvinator Works, Crewe, a standard Birlec Lectrodryer is used to improve the drying out of refrigerator compressor units, to prevent icing up during operation.

This dryer is a "dual-adsorber", that is, whilst one cylinder is drying the other is being "reactivated" for fresh duty. Working on eight hour cycles, continuous drying is provided; as activated alumina—the drying agent—is, for all practical purposes, indestructible, lifelong service will be obtained from this plant.



The cut-out slip will bring you more details of Lectrodryers.

Dryers are also used in other sections of the electrical industry; copper tubing for condensers is blown out with dry air, dry argon is used for lamp and valve filling, complete work and storage rooms are controlled at a low, safe humidity.

Please send me Lectrodryer details, particularly Pub. 82.
Name .....
Position .....
Company .....
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Product .....RC

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World-famous Middle West
MACHINE TOOL MANUFACTURERS

offer permanent positions with much future promise for Machine Tool :—

PROJECT ENGINEERS
CHIEF DESIGNERS
DESIGNERS

Only those anxious to make their future in America need apply. The company does not wish by the offer of higher remuneration to wean from their present employers individuals seeking only shorter term employment and overseas experience.

Applicants should send full information of education and technical training, and should submit in the greatest possible detail a record of their experience, by letter, to :—

EDWARD S. TALLMADGE,
HOTEL BAUR AU LAC,
ZÜRICH,
SWITZERLAND.

Mr. Tallmadge will be in England shortly to interview applicants. In order that he may select the most suitable applicants for interview he requests that they provide him with as much information as possible, and that they do not leave him to refer to past or present employers or colleges for their record. D 730

Positions available for

PROJECT ENGINEERS

at the

KELLOGG INTERNATIONAL CORPORATION

—positions with the career potential only a top-ranking firm can offer.

The men who fill them will be the "job architects" supplying the technical information required for design and development of oil refineries and chemical plants . . . lending their extensive experience to every phase of the project . . . and maintaining considerable liaison work with the customer.

A degree in chemical or mechanical engineering with 8-10 years' diversified experience in the petroleum and chemical industries are minimum requirements. The right men for the job will know the others, in terms of initiative, ability and personality.

Interested persons should send complete details, including salary requirements to the

PERSONNEL MANAGER,
DEPT. 26/H,
KELLOGG INTERNATIONAL CORPORATION
7-8 CHANDOS STREET,
LONDON, W.1.

D 552

EXPERIENCED DESIGNER/DRAUGHTSMAN required to augment the Mechanical Engineering Department of SAMUEL WILLIAMS & SONS, LTD., DAGENHAM DOCK, ESSEX.

The work involves design and development of the Company's own bulk handling equipment, oil storage installation and general engineering. Candidates should have thorough technical training and preferably some shop experience. Canteen facilities are available and the position is permanent and superannuated. A house in good residential area available for suitable candidate. Salary from £750/£900 per annum.

A vacancy also exists in the Drawing Office team for a **JUNIOR DRAUGHTSMAN.**—Applications with full particulars of experience to the PERSONNEL MANAGER. D 727

REQUIRED by Light Engineering Company in South Staffs (in development area) a **QUALIFIED ENGINEER WITH ADMINISTRATIVE EXPERIENCE** to take over the duties of General Works Manager. The position is an important one and affords scope for progressive advancement. The salary is commensurate with experience, and only persons holding or having held executive positions should apply. Housing accommodation could be provided to the selected applicant if desired.—Replies will be treated in the strictest confidence, and should be addressed to: BOX No. 471, W. S. CRAWFORD, LTD., 233, HIGH HOLBORN, LONDON, W.C.1. D 660

While the furnace is roaring away at high fuel cost per hour, it is imperative to do the job of closed box hardening as quickly and as efficiently as possible. HARD-N-DEEP compounds help by giving a continuous supply of carburising gases during all stages of heating, thus speeding up the whole process.

Moreover, a little HARD-N-DEEP goes a long way—for two reasons. Firstly, HARD-N-DEEP is very light and as it is purchased by weight and used by volume, this is an obvious advantage. Secondly, HARD-N-DEEP may be used as a repeater compound. The charcoal loss due to burning away is quite low and this enables HARD-N-DEEP to function excellently, using one part new to two parts old compound. Because of this and reduced carburising times, case-hardening costs can be reduced by the regular usage of HARD-N-DEEP.

The same pound-saving tendency is evident in HARD-N-SKIN, a finely divided powder for surface hardening. HARD-N-SKIN has the ability to cling to involved shapes, to flux readily and to penetrate rapidly to produce a clean case that resists the file—and nothing could be more economical than that.

HARD-N-DEEP and HARD-N-SKIN are produced by the manufacturers of ALMARINE Quenching Oils.

Write to-day for full information.

FLETCHER MILLER

HEAT TREATMENT COMPOUNDS

FLETCHER MILLER LTD. · ALMA MILLS · HYDE · CHESHIRE

Telephone: Hyde 781 (5 lines) *Telegrams: Emulsion, Hyde*

HT14

Large Oil Company requires experienced **BUYER** for West End Offices aged about 30-35, with knowledge of Civil Engineering Equipment, Machine Tools, Pumps, Engines, etc. Pensionable post, salary between £1000 and £1200 according to qualifications and experience.—Write, quoting No. 508, to BOX No. 8844, c/o CHARLES BARKER & SONS, LTD., 31, BUDGE ROW, LONDON, E.C.4. D 725

WORKS MANAGER required for large General Engineering Works, Midlands. Position requires experienced and qualified Engineer capable of initiating and supervising new production methods of large variety of medium and heavy engineering products. Excellent opportunity with good prospects. Pension Scheme. Only first class experienced engineers considered.—Apply in strict confidence and giving fullest details of training, experience, present and past employment, age, etc., to BOX D 729, Offices of ENGINEERING.

ENGINEER/ACCOUNTANT EXECUTIVE required by London Advertising Agency. Must have first-class training and experience in engineering (preferably on sales side) and sound knowledge of production processes. Good mixer desirable, but ability to comprehend requirements and obtain necessary data are essentials.—BOX D 632, Offices of ENGINEERING.

TECHNICAL AUTHOR (INSTRUCTION BOOKS) for Central London. Able prepare, in good English, accurate descriptions mechanical/hydraulic subjects from basic details and drawings. Current engineering experience essential. Good salary and prospects.—BOX D 633, Offices of ENGINEERING.

THE PARSONS AND MARINE ENGINEERING TURBINE RESEARCH AND DEVELOPMENT ASSOCIATION have vacancies in the following sections of the Research Department :—

(A) **GEARING AND LUBRICATION SECTION** dealing with marine reduction gearing, bearings, lubrication and associated problems.

(B) **COMPONENTS SECTION** dealing with hydraulic transmission, high temperature steam and gas turbines, turbine blade vibration, thermal distortion and various turbine components.

(C) **COMBUSTION SECTION** dealing with fuel systems and combustion equipment for marine gas turbines, and associated problems such as turbine blade fouling.

Candidates for the gearing and components sections should preferably be below the age of 30 and have degrees in Mechanical Engineering or Physics, but applications will also be considered from students about to take their final examinations. In the combustion section there is a vacancy for a Research Engineer qualified as above, and also for a Section Leader who could be somewhat older but must have had previous experience of this type of work. D 638

PILKINGTON BROTHERS LIMITED, GLASS MANUFACTURERS, require a **MECHANICAL ENGINEER, AGED UNDER 35,** as Assistant to the Mechanical Engineer at one of their Factories. The duties comprise maintenance and construction of medium and heavy precision glassmaking machinery and installation of new plant. Candidates should have a degree, or its equivalent, in Mechanical Engineering and have gained practical experience by serving an apprenticeship in workshops or otherwise. Applicants should state age and give details of education, apprenticeship and a brief account of their experience.—Replies should be addressed to the PERSONNEL OFFICER (STAFF), PILKINGTON BROTHERS LIMITED, ST. HELENS, LANCASHIRE. D 640

MECHANICAL ENGINEER for research and development required by Engineering Company in the Birmingham district. University degree or equivalent with some experience in precision engineering or instrument design. The appointment offers good prospects and conditions. Staff Pension Scheme. Replies, which will be treated in confidence, should give full details of qualifications and experience and be addressed to "TECHNICAL," BOX D 641, Offices of ENGINEERING.

ENGINEER OR PHYSICIST. Well qualified academically and with experience in experimental physics or in instrumentations, required by well-known Birmingham Engineering Company. Salary commensurate with qualifications and experience. Staff Pension Scheme. Five-day week.—Apply with particulars of age, qualifications, appointments held and salary required to BOX D 642, Offices of ENGINEERING.

SENIOR DEVELOPMENT ENGINEER

Applications are invited for appointment as Senior Development Engineer responsible to the Chief Development Engineer for the work of project teams engaged in the design and development of anaesthetic machines.

Applicants should have a good engineering or science degree together with experience in the design and development of valves, regulators and small mechanisms including electro-mechanical units.

The appointment will be tenable in the London area and housing accommodation can be provided; removal expenses will be paid.

Applications giving full details of age, experience, qualifications and salary required to BOX D 646, Offices of ENGINEERING.

SENIOR DRAUGHTSMAN required, Machine Tool or Sheet Metal Machine experience.—Send full details and salary wanted to F. J. EDWARDS, LTD., 359, EUSTON ROAD, LONDON, N.W.1. D 657

Classified Advertisements continued on Page 102

IMPERIAL CHEMICAL INDUSTRIES LIMITED

Dyestuffs Division, has vacancies at Manchester and Huddersfield for

MECHANICAL
ELECTRICAL
CIVIL
and
STRUCTURAL
ENGINEERING
DRAUGHTSMEN

for design and detail work in connection with new projects for the manufacture of synthetic fibre forming materials and other organic chemicals. Basic minimum qualification required is O.N.C. (preferably H.N.C.).—Applications, with brief details of experience and qualifications, should be made to STAFF DEPARTMENT, HEXAGON HOUSE, BLACKLEY, MANCHESTER, 9. D 592

DRAUGHTSMEN AND DRAUGHTSWOMEN, experienced, for light structural steelwork, sheet metal ducting, and plate work. Good prospects and conditions; five-day week; pension scheme; holiday this year.—WRITE: VISCO ENG'G CO., 161, STAFFORD ROAD, CROYDON. D 441

MONSANTO CHEMICALS LIMITED, NEWPORT, MON., have vacancies for

SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN. Preference given to men having experience in the chemical, petroleum or allied industries who are able to write specifications, issue enquiries, design and produce drawings of piping systems, pressure vessels and layouts. The posts are permanent with good prospects and pension scheme.—Apply in writing stating age, experience, technical qualifications and salary expected to PERSONNEL MANAGER, MONSANTO CHEMICALS LIMITED, CORPORATION ROAD, NEWPORT, MON. G 546

MECHANICAL ENGINEER.—A young man, age 25/30, is required to train as assistant to Director in charge of a large fleet of mechanical equipment. The person appointed will eventually be expected to take over a managerial position in the Company. It will be an advantage if he has served an apprenticeship and in R.E.M.E. A knowledge of electrical equipment is also desirable. Applicants must submit brief particulars of their education and training to BOX D 535, Offices of ENGINEERING.

BROOKE BOND & COMPANY LIMITED require an

EXPERIENCED MECHANICAL ENGINEER to serve as **ASSISTANT IN THEIR OVERSEAS ENGINEERING AND RESEARCH DEPARTMENT.**

The Department is engaged in the design and improvement of machinery for the manufacture of tea, also the designing and layout of tea estates factories embodying standard machinery. This work calls for a wide knowledge of engineering subjects, especially that of drying.

The applicant would do well to realise that the Department is a small unit, necessitating a great deal of drawing office work. To be successful he must be prepared to adapt himself to many duties.

Experience in business routine would be an advantage, since it is often necessary to conduct technical enquiries in connection with the buying of all classes of engineering supplies.

A good salary and excellent prospects will be offered to the applicant who has the requisite training and experience and who wishes to make a career in the field of Tea Manufacture and the relevant machinery.

The position offered might, in the course of time, carry with it the probability of short visits to our Overseas Tea Estates, with a view to gaining experience of operating conditions.

Replies to be addressed to the above DEPARTMENT AT GOULSTON STREET, ALDGATE, LONDON, E.1, giving fullest details. D 539

MECHANICAL ENGINEERS

capable of filling responsible design positions are required by Decca Radar for work in their Research and Development Laboratories. The positions are concerned with the development of the Company's Navigational Aids programmes, and previous experience with electronic equipment is desirable. Applicants should have H.N.C. or higher qualifications. The posts are permanent and pensionable, with excellent prospects for a progressive career. Please write, quoting RLA 118, TO DECCA RADAR LIMITED, 2, TOLWORTH RISE, SURBITON, SURREY. D 414

Imperial Chemical Industries Limited — Wilton Works.

Assistant Technical Officer

DRAUGHTSMEN
MECHANICAL, ELECTRICAL
STRUCTURAL, CIVIL,
INSTRUMENTATION.

There are several vacancies in each category. Applicants should have the appropriate National Certificate and previous Drawing Office experience.

Appointments are to permanent staff.
Staff Pension and Profit Sharing Schemes.
Five-day/39-hour week. Recreation Club with good sporting facilities.
Housing assistance possible in approved cases.

Write for application form to: STAFF OFFICER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, WILTON WORKS, MIDDLESBROUGH, quoting advertisement reference ICI/X/243/a. D 536

BOOTS PURE DRUG CO., LTD., require a **YOUNG MECHANICAL / ELECTRICAL ENGINEER** of at least H.N.C. or preferably degree standard, for the Instrument and Meter Section of their Engineering Department at Nottingham. This position, which is permanent and pensionable, calls for both theoretical knowledge and practical experience of the installation, calibration, operation and maintenance of instruments and automatic controls used in modern industrial air conditioning, heating and power plants and of the meters used for the costing of engineering services. The commencing salary would depend on age, qualifications and experience. The Company normally works a five-day week.—Applications in own writing, giving full details of career to date, should be addressed to the PERSONNEL MANAGER, STATION STREET, NOTTINGHAM. D 597

A TECHNICAL MANAGER is required for an industrial Company in the London area engaged in the Manufacture of Aluminium Foil and Collapsible Tubes. Basic engineering qualifications essential. Age 35/45. Experience in similar work desirable. Please reply giving full particulars to BOX D 591, Offices of ENGINEERING.

SALES CORRESPONDENT. Good permanent position for suitable applicant. Reliability, thoroughness, essential. Engineering or chemical plant experience preferable but not essential. Applicants of any age.—Please write outlining experience and salary required to PERSONNEL OFFICER (DRYER DIVISION), BIRLEC, LTD., TYBURN ROAD, BIRMINGHAM, 24. D 620

JOSEPH LUCAS LIMITED, BURNLEY, require a **YOUNG METALLURGIST OR ENGINEER (GRADUATE)** for fatigue testing laboratory now being established to serve a group of engineering companies. Some previous experience desirable. Salary according to age and experience.—Write, giving full particulars to PERSONNEL DEPARTMENT, HARGHER CLOUGH WORKS. D 507

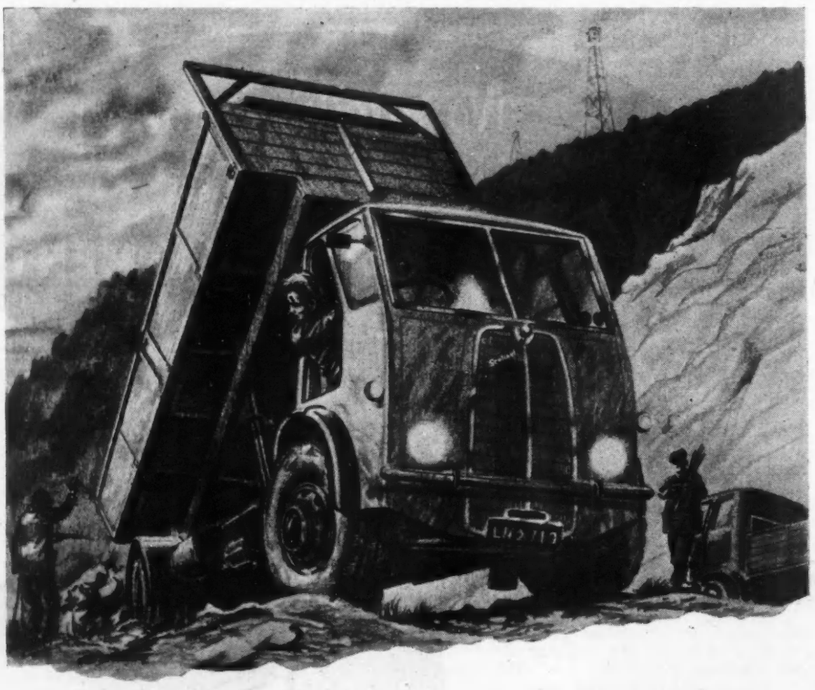
MECHANICAL ENGINEERS, A.M.I.MECH.E., H.N.C., or equivalent qualification, required for London Office. Experience in planning and design of chemical plants, oil refineries, and similar plant essential. Selected candidates will be required to work as job engineers and take charge of sections such as pumps, vessels, piping, etc., supervising the design and preparation of specifications and indents. High salaries offered to engineers having the above qualifications.—Apply to GEORGE WIMPEY AND CO., LIMITED, G.E.M.E.C., WRIGHT'S LANE, KENSINGTON, W.8. D 471

ASSISTANT WORKS ENGINEER. An engineer with good practical experience and the H.N.C. qualification is to be appointed to assist and deputise for the Works Engineer of a multiple-process factory in Birmingham using heavy plant in the manufacture of metals. Pension scheme, canteen, sports club. Holidays this summer by arrangement.

Applicants should give full details of their careers and state the salary desired. All replies will be treated as strictly confidential.—BOX NO. A.33, T & G, 167, HIGH HOLBORN, LONDON, W.C.1. D 578

RESEARCH ENGINEER required for the Mechanical Engineering Section of a Metallurgical laboratory to undertake research work of a wide nature. Qualifications should be a degree in Engineering or Corporate Membership of a recognised Institution, with experience if possible in fatigue and creep of metals. Salary up to £850 per annum.

Apply giving age, full details of education and experience, to THE DIRECTOR OF RESEARCH, FULMER RESEARCH INSTITUTE LTD., STOKE POGES, BUCKS. D 532



a match for the toughest conditions

Fast road work or new projects in formidable country—it's all the same to Sentinel vehicles. The load-carrying units—chassis, axles, springs—are built to a strength far in excess of load. The famous Sentinel engine is completely accessible for normal maintenance to filters, fuel injection equipment, and valve gear and gives outstandingly vigorous performance for low fuel consumption.
Sentinel vehicles are made for every type of transport—GOODS, PASSENGER, ANIMAL CONVEYANCE.

Sentinel is always in front of economic transport

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LONDON OFFICE 60 BUCKINGHAM PALACE ROAD SWI TELEPHONE SLOANE 0098
A METAL INDUSTRIES GROUP COMPANY
SS/2/A. 1451

ASSISTANT ENGINEER required for Power Company distribution department in Malaya. Age 25-30. Grad. I.E.E. or H.N.C. with recognised electrical apprenticeship. Experience should cover L.T. Distribution and Maintenance with some knowledge of small diesel generating sets. Salary £980 by £56 to £1316 per annum, plus cost of living allowance, free passage, quarters and medical attention. Pension Scheme.—Write BOX E.G.603, c/o 191, GRESHAM HOUSE, E.C.2. D 653

IMPERIAL CHEMICAL INDUSTRIES, LTD., METALS DIVISION, has a vacancy for a **QUANTITY SURVEYOR AGED 27/32.** Preference will be given to a qualified Chartered Surveyor but one in course of qualifying would be considered. The successful applicant would be expected to prepare full bills of quantities and assume full responsibility for final measurements and accounts on industrial projects. The post is a pensionable and progressive one.—Application forms may be obtained from STAFF MANAGER, I.C.I. METALS DIVISION, KYNOCH WORKS, WITTON, BIRMINGHAM, 6, quoting ENG/2. D 669

THE STANTON IRONWORKS COMPANY, LIMITED, NEAR NOTTINGHAM, invites applications for the appointment of **ASSISTANT WORKS MANAGER** on its Concrete Plant. Applicants should have had a good general engineering training, including a knowledge of precast concrete construction, and preferably have held a similar position in the Precast Concrete Products Industry. A knowledge of prestressed concrete would be an advantage. The post is superannuated.—Write in confidence giving age and full details of qualifications and experience to the Staffing Officer. D 664

A.E.C. LIMITED

require

DETAIL DRAUGHTSMEN

to fill vacancies in recently-completed extension to Engineering Drawing Office. Experience of the motor industry would be an advantage. Modern office and equipment, excellent opportunities for progress, good salary offered, five-day week, pension scheme and canteen facilities.—Applications in writing, giving age, experience and salary required, to STAFF RECORDS OFFICE, DEPT. F, WINDMILL LANE, SOUTHALL, MIDDLESEX. D 212

CANADA.

MECHANICAL ENGINEER required for supervision of design for a variety of heavy machinery. Applicant must be an engineering graduate or have equivalent status, 35 to 40 years of age, capable of promoting design for both economy and practicability, as well as control of quality consistent with design intent and facilities of manufacture. Please reply in detail, stating experience, education, etc. All replies will be kept in strict confidence. Salary commensurate with experience and qualifications. Office and shops in Montreal area.—Reply to DEPARTMENT D.E., CANADIAN DEPARTMENT OF LABOUR, 61, GREEN STREET, LONDON, W.1. D 668

An Industrial Company outstanding in its own field has a vacancy in its production department for a

YOUNG MAN WITH DRIVE AND WILLINGNESS TO TAKE PROGRESSIVE RESPONSIBILITY. First rate prospects are offered to the successful applicant who should have a Public School education, a Degree or A.M.I.Mech.E. standard of qualification and a good apprenticeship. Some executive experience of modern production methods is essential. The appointment is pensionable and carries a salary up to £2000 per annum.—Applicants aged about 30 are invited to send full particulars of their qualifications, etc., to BOX D 667, Offices of ENGINEERING.

JOHNSON & PHILLIPS, LTD.

CABLE WORKS MANAGER.

JOHNSON & PHILLIPS, LTD., require a Manager for their Paper and Rubber Cable Works. Those interested should send full details of their training and career to the Managing Director. All correspondence will be treated in absolute confidence.
JOHNSON & PHILLIPS, LIMITED,
CHARLTON, LONDON, S.E.7. D 720

THE RESEARCH DEPARTMENT OF METROPOLITAN-VICKERS ELECTRICAL CO., LTD., TRAFFORD PARK, MANCHESTER, 17, has a vacancy for an **ENGINEER OF HIGHER NATIONAL CERTIFICATE** standard or equivalent for research and development in the Laboratory and in the Works of a wide variety of machining processes.
Write, giving full particulars including age, sex, nationality, education, and experience, to: THE PERSONNEL MANAGER, METROPOLITAN-VICKERS ELECTRICAL CO., LTD., TRAFFORD PARK, MANCHESTER, 17, quoting "M.2." D 553

THE QUASI-ARC COMPANY, LIMITED, BILSTON, STAFFORDSHIRE, requires **MECHANICAL AND ELECTRICAL ENGINEERS** interested in a concentrated course of training in all principal types of manual and automatic arc welding processes and equipment, with a view to taking up Technical and Technical Sales careers at Home or Overseas.—Reply at once to THE SECRETARY, THE QUASI-ARC COMPANY, LIMITED, BILSTON, STAFFORDSHIRE, stating age, qualifications and experience. D 731

DRAUGHTSMAN with good mechanical engineering experience required for interesting and important research and development work. Excellent opportunities for advancement. Age 25-30 years.—Apply in writing, giving full particulars of experience and qualifications to DOWSETT ENGINEERING CONSTRUCTION, LTD., TALLINGTON, STAMFORD, LINCS. D 734

TECHNICAL AND SALES ENGINEER required, knowledge of heavy steel works cranes and previous outside experience preferable. A salary commensurate with experience would be paid. A Pension Scheme is in operation.—Apply giving age and details of experience in chronological order to ADAMSON-ALLIANCE CO., LTD., 165, FENCHURCH STREET, LONDON, E.C.3. D 713

AUTOMATION.

Major industrial organisation, setting up Research and Development Laboratories in the Birmingham area, has the following vacancies :—

(1) SENIOR PROJECT ENGINEER, starting salary £1800 to £2500 per annum, depending on age and qualifications. Candidates should have experience of Research and Development in connection with electronic computors, business machines, and data transmission equipment.

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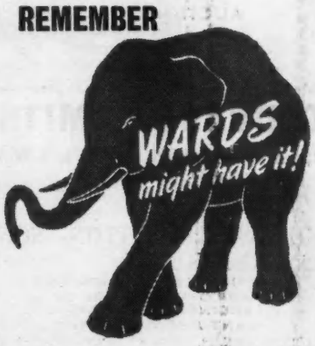

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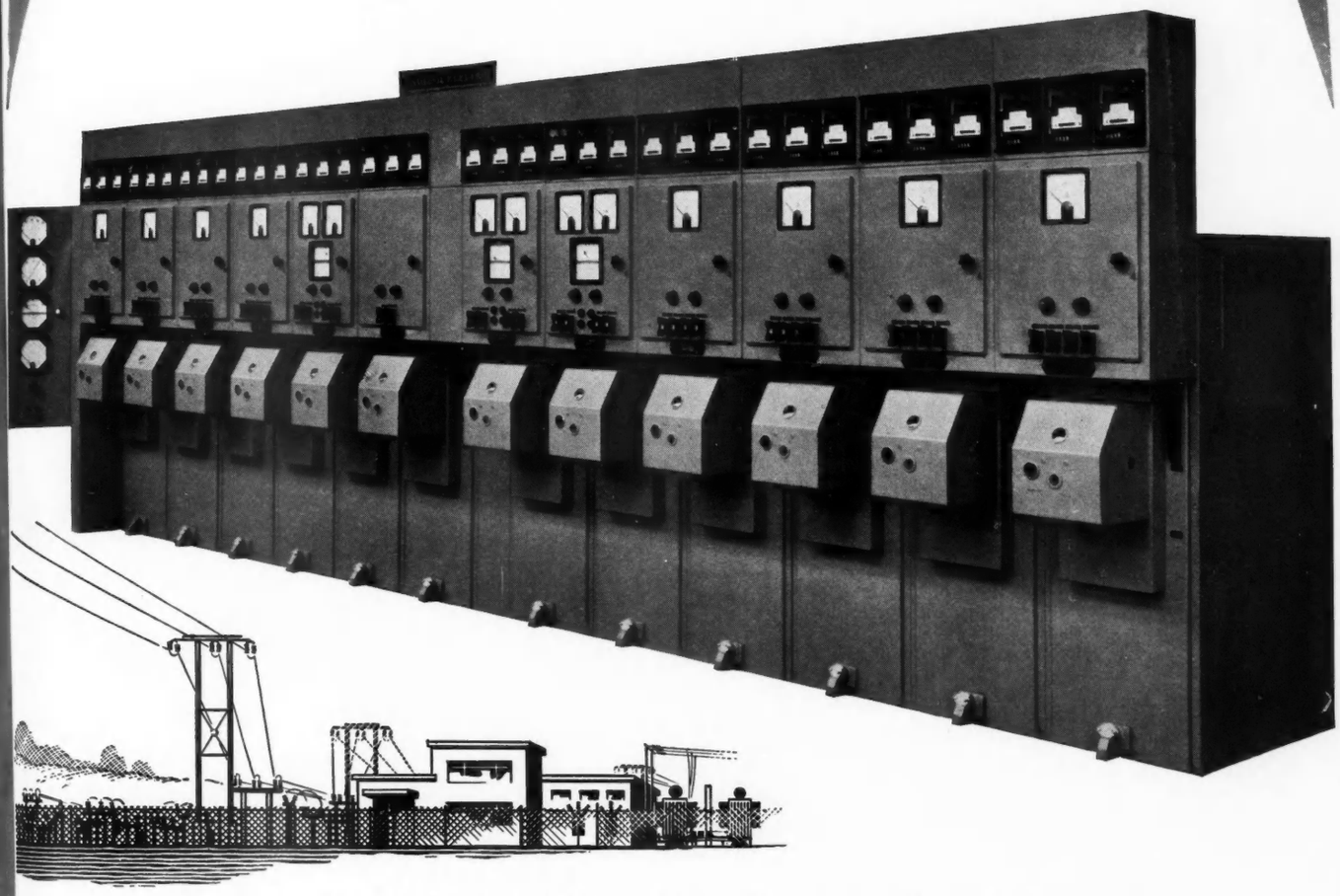

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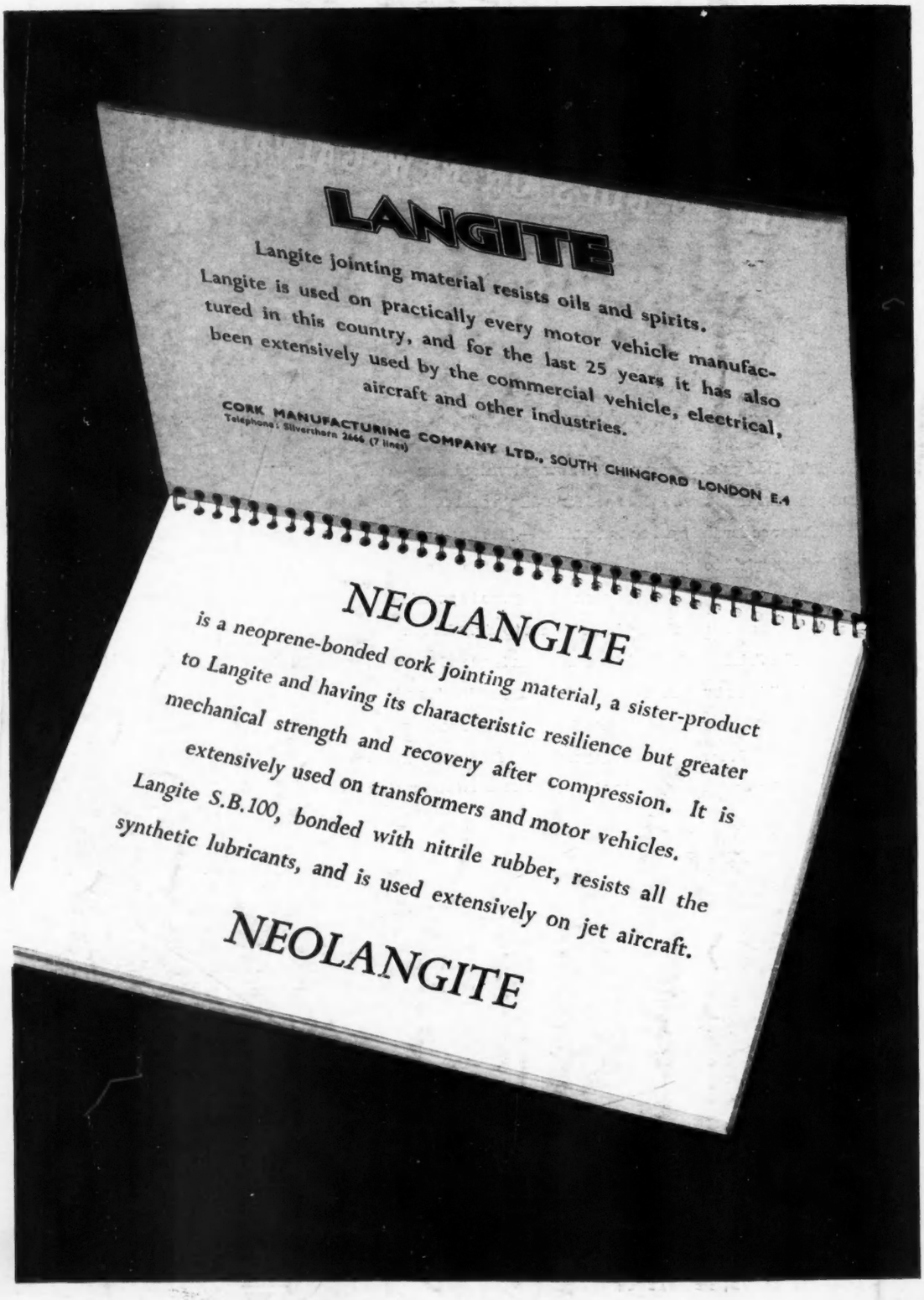
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